We shall nobly save or meanly lose the last hope of Earth.
—ABRAHAM LINCOLN.

CONTENTS FOR FEBRUARY, 1943

The Role of Education in Our Present Emergency—*Ralph W. Tyler*. 99
The Nation Calls for Mathematics—*William L. Hart* 105
Elementary Science Through a Victory Garden—*Dorothy V. Phipps* 117
Radio's Relation to Victory—*Lieut. Gen. J. G. Harbord* 126
High School Science and Mathematics in Relation to the Manpower Problem—*Robert J. Havighurst and Others* 127
1. Introduction 127
2. Physics 131
3. Biology 138
4. Chemistry 141
5. Mathematics 145
6. Summary and Conclusions 152
Notes from a Mathematics Classroom—*Joseph A. Nyberg* 158
High School Chemistry Proves Its Worth—*John Rosengren* 162
A Modern Method of Teaching Science—*Norman R. D. Jones* 165
The Forty-Second Annual Convention of the Central Association of Science and Mathematics Teachers—*Ray C. Soliday, Secretary* 168
The Friday Morning General Session—
The Friday Noon Luncheon—
The Saturday Morning General Session—*R. W. Woline* 168
Biology Section—*Cecilia J. Lauby, Secretary* 170
Chemistry Section—*John O. Collins, Secretary* 171
Elementary Mathematics Section—*Butler Laughlin, Secretary* ... 173
Elementary Science Section—*Anna E. Burgess, Secretary pro tem* .. 173
General Science Section—*Mark P. Anderson, Secretary* 174
Geography and Conservation Section—*Floy Hurlbut, Secretary* ... 175
Mathematics Section—*E. G. Hexter, Secretary* 176
Physics Section—*C. W. Jarvis, Secretary* 178
The Elementary School Group—*Catherine Cullerton, Secretary pro tem* 179
Junior College Section—*William W. Gorsline, Chairman* 180
Junior High School Section—*Mark P. Anderson, Secretary* 180
Senior High School Meeting—*Nathan A. Neal, Chairman* 181
Problem Department—*G. H. Jamison* 181
Science Questions—*Franklin T. Jones* 187
Books and Pamphlets Received 192
Book Reviews 193

SCHOOL SCIENCE
AND
MATHEMATICS

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THE ROLE OF EDUCATION IN OUR PRESENT EMERGENCY*

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When defined broadly to include all efforts to change the patterns of reaction of human beings, there can be no question that education is a primary essential to war, both for military and for civilian life. The Army has identified more than 700 occupations involved in its operations. Some of these occupations do not exist in civilian life, such as gunner, bombardier, gauleiter; others are found in the Army in very different incident ratios from those in civilian life; for example, the ratio of physicians and surgeons in the Army is 7 per 1000, while in civilian life it is less than 2 per 1000. The difference in ratio for cooks and bakers, auto mechanics, radio repairmen, radio operators and a hundred other occupations is equally great. If education is defined to include vocational training, it is obvious that a major task of the modern army is education.

A similar analysis can be made for wartime civilian occupations. Munitions manufacturing, airplane production, metallurgical trades, and transportation are only a few illustrations of occupations with ratios of incidence in wartime vastly different from those in peacetime. Vocational training in wartime is essential for large groups of civilians as well as for men and women in the military services.

Many of these occupations involve applications of science

* Address delivered at the Annual meeting of the Central Association of Science and Mathematics Teachers, November 28, 1942.

and mathematics. Teachers in your fields are in great demand to meet these needs for vocational training. However, it is not my purpose to discuss the role of science and mathematics in wartime vocational training. Such training is necessary and must involve many of you. But its obvious significance prevents its neglect. Science and mathematics instruction for purposes of general education is not being given thoughtful consideration during this war period. Hence, this paper is directed toward the issue of general education in wartime.

Lest I be misunderstood, may I make clear that I believe all of us should be concerned to see that three educational tasks are accomplished, namely, the training of military personnel, the training of civilian personnel for essential civilian occupations and general education for good citizenship essential now and in the postwar period. The question is, What responsibility should the school and college take for each of these tasks?

Educational institutions are under pressure from many groups. For example, those interested in promoting inter-American understanding have prepared teaching materials, bibliographies, and traveling exhibits. Through letters from Washington, through regional agents and personal visits, schools are urged to include these materials in their curriculum. The Office of Price Administration has a division of Educational Relations and through national and regional offices the schools and colleges are asked to emphasize conservation, understanding of wartime economics and the like. The Civil Aeronautics Authority and the United States Office of Education have exerted strong pressure on the schools to include pre-flight courses and have subsidized the preparation of a series of textbooks which the schools are urged to use.

Through funds from the Army Services of Supply, the Office of Education is preparing outlines and arranging for the preparation of textbooks for pre-induction courses in high school and college. From Washington also comes the proposal for a school Victory Corps, with its recommended curriculum offerings, its proposed extracurricular activities, its symbols and insignia. Through schools and colleges most of the ESMWT courses are administered. These proposals, projects, and pressures are all focused upon the local institutions. Many local administrators and teachers do not recognize the confusion of voices in Washington. They believe that the government wants them to do all of these different things. One school system was reported in

the press to have thrown out its curriculum and to be operating entirely on the basis of these heterogeneous and conflicting war projects.

It is probably unnecessary to remind this group that we do not have a national system of educational control in this country. Education is a state function and in most states the working out of the educational program has been delegated to the local districts. In educational matters, Washington speaks with many voices and without authority. The local school or college cannot expect to get an educational program handed down from Washington. The local institution cannot abrogate its responsibility for planning and executing an intelligent, unified program of education for its children and youth. Agencies in Washington and elsewhere may quite properly bring facts, ideas, and proposals to the attention of the local staff but the acceptance or rejection of these proposals and the development of an effective coherent program is our task. We cannot side-step it.

What decisions should we make about training and about general education? Perhaps we can be helped by examining certain data. On November 10, President Roosevelt stated that the plans for the Army and Navy involved the mobilization into military service of 9,700,000 men by the end of 1943. He went on to say that to supply the armed forces and to provide for a minimum civilian economy would require about 90,000,000 persons gainfully employed. At this time we have approximately 62,000,000 gainfully employed. Hence, we are expected to increase our employment by nearly 50 per cent in the next year.

To expand our labor supply so greatly will require the transfer of all able-bodied males from nonessential war occupations to essential ones. It will also require a vastly augmented force of women workers. All able-bodied women above 18 who have no children and a considerable number with children will probably be drawn into essential work. Even this is not likely to provide all of the needed labor supply. Upwards of 4,000,000 workers are likely to be drawn from the age groups below 18.

May we examine another set of data? The present military mobilization plans call for the induction of able-bodied 18 year-old boys as soon as those of 19 years have been inducted. Thereafter physically fit boys will be inducted some time after their eighteenth birthday, perhaps within two to six months. These boys will be sent to camps for basic training of thirteen weeks.

About 10 per cent of them will be selected for advanced specialized training after the thirteen weeks. Some of this advanced specialized training will be given in higher educational institutions but it should be remembered that only about 10 per cent of the higher institutions will be used for this post-induction training and that the content of the training will be determined by the Army. Boys who enlist in the Navy or in the Naval Reserve programs will be given somewhat different treatment. For the time being the naval enlisted reserves are to continue their training and education in the colleges. However, the broad outlines of the picture are clear. Boys have until eighteen to participate in an educational program which is determined by the local school or college. After eighteen their training is determined by military needs.

Let us consider another set of data. Serious shortages are developed in certain professional fields. The shortage of teachers is estimated at 50,000, especially acute in the rural areas where thousands of schools have been unable to open this fall because of lack of teachers. The shortages of doctors, nurses, and engineers are alarmingly high. These shortages cannot be repaired in a brief period. Labor shortages such as welders, riveters, auto mechanics, can be cared for with a relatively short period of instruction. Professional personnel require a much longer time for their education. I fear that schools have spent too much time worrying about needs which can be met with short-time training programs and have given too little attention to needs which require long-time effort and sequential planning.

Another consideration which has some implications for our future planning is the different ratio of incidence of occupations in the Army and in peacetime civilian life. It is estimated that there are now five times as many auto mechanics in the Army as are necessary in peacetime civilian life; twelve times as many radio technicians, 400 times as many radio operators. The retraining of men after the war is a vast educational problem. It involves vocational guidance and placement as well.

I have emphasized the conflicting aspects of the problem of training for the military personnel because I have noted a tendency for schools and colleges to duplicate the training for young men which the Army will provide while neglecting basic educational needs which are not likely to be met in later military life. The Army cannot leave to the schools and colleges the responsibility of providing instruction basic to effective military

operations. Many soldiers do not come direct from schools or colleges. This responsibility for basic military training should and will be met by the Army. For the schools to develop pre-induction programs which duplicate Army training programs is a serious waste of educational time and effort when both must be rationed. The school must look carefully at both short-term and long-term needs of its students. It must consider what other educational and training programs will be available to its students and in the light of these considerations seek to provide for the essential educational needs which will not be met elsewhere.

The school must also consider the effect of severe labor shortages. If, within a year, some 4,000,000 workers are drawn from those who are under 18 years of age, there seem to be but two possibilities. The compulsory education age will be lowered and those youths of 14, 15, 16, and 17 who wish to quit school for work will be given working certificates or the school will take responsibility for combining a program half of work and half of schooling which will produce the necessary labor but deny no one of this age group some educational opportunity. Can there be any question that the second plan is preferable to the first? If the school uses co-ordinators to supervise the work experience much like the present program of training in diversified occupations, it is possible to safeguard the working conditions of youth and at the same time to provide a better correlation between instruction and work experience so as to get some educational benefit from the half time spent at work. It is likely that a program of this sort running twelve months in the year would accomplish an educational program equivalent to the present full-time educational program for nine months in the year.

Any such program of education requires planning and initiation. It will not be done for us. We must accept the responsibility not only to plan an educational program to meet emergency labor shortages but also to provide the best type of human being for military and civilian service to win the war and to make the good life after the war. We are prone to forget the total task. To the recent meeting of the Association of American Colleges, our Commander in Chief sent the following greeting:

October 22, 1942

Dear Dr. Snavely:

Winning the war is now the sole imperative. But we may seem to win it and yet lose it in fact unless the people everywhere are prepared for a peace

worthy of the sacrifices of war. Furthermore, the real test of victory may well be found in what the people of the victorious United Nations are prepared to do to make the "United" concept live and grow in the decades following the peace.

Education, world-wide education, especially liberal education, must provide the final answer. Colleges can render a fundamental service to the cause of lasting freedom. Theirs is the opportunity to work with sterling young people who give great promise of leadership.

Let me extend greetings to the liberal-arts colleges, the mainspring of liberal thought throughout the country.

Very sincerely yours,
(signed) FRANKLIN D. ROOSEVELT

If liberal education is to provide the kind of persons our President hopes, it must not become a hodgepodge of unrelated courses, nor a continuous duplication of the training which the Army will provide more effectively. War does not change the aims of general education. The good life, the good man, the good society—these educational ideals must not be pushed aside. I am not suggesting that schools and colleges adhere to a policy of "business as usual." We must meet educational demands under new and critical conditions. Both schools and colleges will have their students for a shorter time. It is our responsibility to see more clearly than ever what are the most important objectives of education, to re-examine our whole program to see that these goals are most efficiently promoted.

We may want to use materials dealing with radio, with aeronautics, and the like; not because we seek to make radio technicians or pilots of our students, but because we can use these vital materials as means to the end of a general education to develop intellectual skills, social ideals and attitudes, and self-disciplined habits. We must make a comprehensive plan for wartime education. The criteria for a good curriculum are as valid now as before the war. An educational program to be effective must aim toward common objectives, must provide for sequential development, must give opportunity for thought and action on the part of the student, must be well motivated, unified, and coherent. In our confusion of the past year, these criteria have largely been forgotten. Let us develop a truly effective educational program, for now we have no time to waste in education.

Our high schools must see that larger numbers of pupils gain a more thorough mastery of mathematics and science.

—*John W. Studebaker*
U. S. Commission of Education.

THE NATION CALLS FOR MATHEMATICS*

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Although I intend to make many references to advanced mathematics, my main emphasis today will be placed on *secondary* mathematics. As recently as two years ago, if I had chosen a topic for presentation to your organization, I might well have spoken on the theme "*Mathematics* Calls to the Nation," instead of my present reversal of this, "The *Nation* Calls for Mathematics." Two years ago I might even have used the title "Mathematics Calls *in Vain* to the Nation" because at that time there was little evidence of an awakening of the field of education to the dangers inherent in a national lack of mathematical preparedness at elementary and intermediate levels. However, I am not recalling this past situation in order to recommend that those of us who work in the field of mathematics should now adopt a smug "*I told you so*" attitude toward people who failed to appreciate our warnings. Such an attitude, of course, is undesirable. Moreover, we must not absolve ourselves entirely from any blame which may fall on educators because of troublesome mathematical deficiencies in the backgrounds of some of the men and women on whom the nation must depend for its salvation during the present emergency. However, it is appropriate to examine the record briefly in order to appreciate the situation which caused, first, the tardiness in the national recognition of the importance of widespread teaching of secondary mathematics, and, second, the final realization of the necessity for immediate constructive action in this field.

During the years 1939 to 1941, the lack of appreciation by the general public of the importance of mathematics for national defense may have been due party to the placid attitude with which the United States then faced the world emergency. A more significant reason for the slowness of the development of national consciousness of the need for mathematics was the lack of general knowledge of the extent of the technical demands of modern warfare. This former ignorance of military affairs is not surprising because, in the past, the United States has usually been geared to a peacetime economy with only brief intermis-

* Delivered at the annual meeting of the Central Association of Science and Mathematics Teachers in Chicago, November 28, 1942.

sions when military affairs were deemed of importance. Hence, during the years 1939 to 1941, it was natural to find a large element of surprise in the reaction of the public and of the general field of education to indications that modern military science in its most important branches is a *mathematical* science for most of the officers and also in many respects for a large fraction of the enlisted personnel down through the lowest ranks in the Army and Navy.

However, the present extreme need for mathematics was definitely foreshadowed by trends in warfare over the last twenty-five years. This prominence of mathematics, or, better said, of the physical and engineering sciences, is a consequence of the mechanization of land warfare, the growing emphasis on air warfare, the continued importance of sea communications and naval warfare, the wartime uses of the latest scientific advances, and the resulting production program for industry. As a result of these causes, it is now recognized on all sides that the present need for men and women with substantial mathematical training completely dwarfs similar demands which arose during the first world war. At that time, the Army Air Corps was in its infancy, the air arm of the Navy was practically nonexistent, and airplanes had such short ranges that the problem of their navigation was simple. Now, we are faced with the problem of giving multitudes of airmen an understanding of their complicated equipment and we must train tens of thousands of young navigators so that they can take airplanes or ships thousands of miles over trackless oceans with the aim to arrive at tiny islands or other objectives and then to return to home bases. Bombing from airplanes in 1918 was an elementary process; now, bombing is a highly technical science involving delicate instruments and a mathematical approach. Anti-aircraft firing at the slow moving targets in 1918 was mere child's play, mathematically, compared to firing today at high speed aerial targets which fly at altitudes as great as 30,000 feet or even beyond the altitude at which our best anti-aircraft guns can fire successfully. In contrast to relatively moderate needs during 1917–18, our Navy now needs tens of thousands of candidates for the technical curricula which lead men into the commissioned ranks in the Navy's air force as well as thousands of other candidates for positions as deck officers. And, the Army and Navy at present are engaged in training hundreds of thousands of enlisted specialists, most of whom need a reasonably complete foundation

in the elements of secondary mathematics in order to appreciate their course work. Meanwhile, on the civilian front, industry and the essential professions are searching for seemingly unlimited numbers of men and women with technical and therefore mathematical training at all the various levels. In the light of these facts, it is no exaggeration to say that practically *all* of the intelligent young men, and large numbers of intelligent young women, should be well trained mathematically if the United States is to realize to the fullest extent the wartime advantage which it should possess due to our extensive system of public education.

It is of some interest to observe the nature of the error made with respect to mathematics in the early national planning for the present emergency. The error did *not* consist of forgetting that mathematics would play a necessary role in time of war. Thus, the Army and Navy always have recognized the military importance of mathematics, particularly in the curricula at West Point and Annapolis. Also, at any time, decently informed educators would have been ready to admit that mathematical training would be important for *some* officers and enlisted men in the armed forces and for *some* men in industry. It seems apparent that the main error in national mathematical planning for war was that few people, even among mathematicians, originally had a proper conception of the *tremendous extent* to which mathematics would prove useful. A related and very serious error was made by the leaders in education who did not focus on the dangerous wartime effects of *twenty-five years of decreasing emphasis on substantial mathematics in secondary education.* This unfortunate condition of the preceding generation was bound to cause a dangerous progressive decrease in the national reservoir of men and women possessing fundamental training in mathematics. However, we cannot lay the blame for this second error on the Army and the Navy; their staffs had a right to assume that the high schools were continuously pouring large increments into the nation's reservoir of citizens with mathematical backgrounds. The field of education would truly be in a sad state if it were to place the responsibility for educational planning on the shoulders of military staffs! In this connection it is commendable of the Army and Navy that, soon after they had had a chance to sense the mathematical deficiencies of men entering the various classifications of the armed forces, official spokesmen for the War and Navy Depart-

ments took actions[1] to acquaint the field of education with the seriousness of the situation.

It is of some interest to remark that the existing critical national situation in regard to mathematics in the war effort was anticipated to a considerable extent by mathematicians early in the present world emergency. I am referring here to the fact that, in 1939, a joint War Preparedness Committee was formed by the American Mathematical Society and the Mathematical Association of America. You may be aware that this committee, in addition to carrying on various general activities, maintains the following specific programs, through three subcommittees. One subcommittee on *research for national service* provides machinery to place industry, government, and the armed forces in contact with the best men available for the extremely essential and frequently unexpected mathematical research which must be carried on as a part of the war effort. A second subcommittee on *preparation for research* has encouraged greater emphasis on applied mathematics in the training of graduate students of mathematics. A third subcommittee on *mathematical education for national service* first investigated the mathematical needs of the armed forces and industry. In February, 1941, this subcommittee commenced issuing publicity to arouse educators and the leaders in the armed forces to the wartime necessity for immediately increasing emphasis on the study of mathematics, especially in the high schools. I recall to you that, during the summer of 1941, with the co-operation of your organization and the National Council of Teachers of Mathematics, the Subcommittee on Education for Service published,[2] and distributed to key educators all over the United States, a comprehensive report outlining the minimum mathematical needs of the various branches of the armed forces and industry. And, this report urged prompt action by the secondary field, colleges, and centers of adult education to remedy the observed dangerous mathematical deficiencies in the past training of many adults and also of students who were still in the high schools and colleges.

[1] See, for example, the letter from Admiral C. W. Nimitz to the University of Michigan calling attention to mathematical deficiencies of many of the men entering the Navy, published in the *Mathematics Teacher*, page 88, vol. XXV, February, 1942; parts of a speech entitled "The Navy and the Schools," by Lieutenant Commander Paul C. Smith, published in the *Mathematics Teacher*, page 248, vol. XXXV, October, 1942; recommendations for pre-training in mathematics, physics, and astronomy for aviation cadets, issued by the Army Air Corps, published in the *American Mathematical Monthly*, page 274, vol. 49; April, 1942.

[2] Published in the *American Mathematical Monthly*, the *Mathematics Teacher*, and SCHOOL SCIENCE AND MATHEMATICS (page 779, vol. XLI, November, 1941).

In retrospect, as chairman of the subcommittee which drew up the report which I have just mentioned, I cannot help regretting that the administrative side of the secondary field acted so slowly in taking measures recommended in the report. In fact, no significant general action in this direction was taken until many months after we had actually entered the war and until suggestions for appropriate measures came directly from spokesmen for the Army and Navy. In the face of actual war, such requests had the natural explosive effect. Now, all parts of the field of education are patriotically co-operating in a wartime program for emphasizing the teaching of mathematics at all levels. The most official evidence as to this present mathematical situation in the schools is the record of a conference of the National Council of Chief State School Officers, held with the representatives of the War and Navy Departments and the United States Office of Education in May, 1942. This conference issued a report[3] entitled "A Wartime Program in Mathematics and Physics." The program outlines an emergency course and also a regular four-year sequence in secondary mathematics, and presents commendable general viewpoints about mathematics.

Up to this point I have been discussing, mainly, the *background* of the call for special war service in the field of mathematics. This service, we must remember, is in addition to most of the pre-war activities of mathematics because they occur largely in essential categories associated with the war effort. It is natural that the emergency needs should fall almost entirely in the field of *applied* mathematics, as contrasted to pure mathematical theory. However, at advanced levels, it is sometimes necessary to develop new theory before applications can be attacked successfully. Frequently, the mathematical elements involved in the applications are so interwoven with the physical or engineering background that it is difficult to decide on the relative importance of the mathematical part as compared to other features. Many of the most vital and interesting war applications of mathematics occur in research which, for military reasons, must be kept secret at least until after the war. Hence, it is obviously impossible for anyone to exhibit a complete picture of the mathematical part of our present vast national program. Consequently, I shall refer only to enough

[3] Copies can be obtained at fifteen cents each, postpaid, from Mr. Paul Eddy, Editor of Publications, State Department of Education, Tallahassee, Florida.

items relating to mathematics in the war effort so that we may have concrete situations in mind as a background later.

I wish to say only a few words specifically concerning the wartime uses of mathematics in industry and engineering, because these applications are similar to those met in times of peace. Let me only emphasize that such use of mathematics has tremendous added importance during a war. Moreover, we should note that the industrial applications occur not only in the fields of activity of college trained engineers but, also, at more elementary levels, particularly at the level of arithmetic, elementary algebra and geometry, and trigonometry, in the work of hundreds of thousands of skilled employees in the offices and at the machines in our industires, professions, and government bureaus.

Let us turn now to the less familiar uses of mathematics which have wartime importance and, first, consider those applications where the worker must have training equivalent to that implied by a Ph.D. degree in mathematics. War work of this type involves the solution of the special problems as contrasted to routine actions in the field of engineering and in the wartime research being carried on by the Army, Navy, government bureaus, and industry. Thus, mathematical problems of extreme complexity, whose solutions involve the most advanced mathematics, are met in aeronautical research. Astronomically large numbers of man-hours of mathematical research as well as physical and engineering investigations are involved in the planning of each advance in aircraft design. Skilled mathematical work of the research type is necessary in the development of fire control devices for artillery and in the planning and manufacture of all the complicated guns and other munitions which come under the head of naval and army ordnance. Thus, a special unit manned by well qualified mathematicians is an indispensable cog in the ballistic division of the Ordnance Department of the Army. These mathematicians carry the responsibility for solving many of the fundamental problems which arise in the design of guns, projectiles, bombs, bombsights, and in the preparation of the tables employed by the artillerymen in actual service. A few highly qualified mathematicians are essential officers in that part of the intelligence service which deals with codes. Advanced mathematics enters also in the present active research in the field of meteorology, which is so vitally important in aerial warfare as well as in

peacetime aeronautics. Electronics is another field in which present research is very essential and very mathematical.

Below the research level in mathematics, we find a growing demand from the Army and Navy, as well as from certain industries and various government bureaus, for men and women who have an undergraduate college minor or major in mathematics, together with other required training. This demand, together with the increased need for teachers of mathematics in the high schools and colleges, is just now giving rise to an acute shortage of such man-and-woman-power in our war effort. A moderately advanced mathematical background of the type just described is one of the prerequisites for the advanced course of study being taken at selected universities by thousands of cadet officers in training to serve as meteorologists in the Air Corps of the Army and the Navy. A similar background is desirable for men who take advanced training in electronics in the Signal Corps. Women with moderate training in college mathematics and various other essential subjects are needed to replace men in certain war industries. A woman with a college major in mathematics supplemented by work in statistics is now considered as a pearl of great price in industry and in various government bureaus.

Finally, let us mention the wartime applications of elementary and secondary mathematics. It can be said with ample justification that the war and its associated industrial problems have placed a *very substantial new halo of importance* on such mathematics, through the stage of plane and spherical trigonometry. The armed forces and industry are seeking, without proper success, for hundreds of thousands of men and women possessing *confident* knowledge of the working details of elementary and secondary mathematics through the stage of trigonometry. In view of the fact that the mathematical needs of men in the armed forces have been described in detail in the report of the Subcommittee on Education for Service (loc. cit.), at this point I shall mention only the mathematical background desirable for an aviation cadet, in either the Army or the Navy. He should have well established space intuitions, such as result from some sort of an exposure to solid geometry, a well refreshed knowledge of arithmetic, elementary algebra, and the basic parts of plane geometry, and a respectable acquaintance with plane trigonometry on the computational side. Also, the cadet will find it useful to know the fundamentals of spherical trigo-

nometry if he desires to obtain complete control over the theory of celestial navigation. Mathematical pre-training for the aviation cadet proves useful in his study of meteorology, in reading and making graphs, when he is required to use various mathematical tables, in the study of elementary aerodynamics where considerable use is made of algebraic formulas, and in his course in mechanics, maps and charts, radio communication, bombing theory, and navigation. Those aviation cadets who receive training as navigators will find more use for trigonometry than those who are trained only as bombardiers or pilots.

Let me close my brief description of the nature of the wartime demand for mathematics by calling your attention to a very significant indication of the extent to which young men of military age have become convinced of the need for mathematics.

In Minneapolis, a self-appointed committee was organized about two months ago to foster free mathematical instruction for young men out of school, who are about to enter the armed forces. The financial conditions of school boards in Minnesota seemed to rule out the possibility of quick action by them which would accomplish the aim which the committee had in mind. Courses were outlined and the idea was taken up with enthusiasm and pressed vigorously by the Committee on Education of the Minnesota Civilian Defense Council. Volunteer teachers were obtained. In answer to the first announcement of the free courses, eight hundred men appeared for the evening classes given in over ninety communities, of all sizes, in the state. In about one hundred other smaller communities, the few men asking for mathematical aid are being assisted through volunteer tutoring. Most of the men who appeared for these classes are carrying full time day work and yet they are spending several nights per week in studying mathematics. I think that the response to this volunteer mathematical instruction in Minnesota shows clearly the intense desire of the young men of military age to obtain mathematical knowledge. They *deserve* to be taught all the mathematics which they can assimilate. I urge all of you to consider the possibility of actions similar to the Minnesota plan[4] in any community where *free* instruction in mathematics for adults is not immediately available through the public schools.

[4] Information concerning its operation can be obtained from Professor Clifford P. Archer, University of Minnesota, Co-chairman, Committee on Education of the Civilian Defense Council for the State of Minnesota.

As a final section of my address, I shall offer a few opinions about the mathematical situation in the secondary field.

First, I suggest that the war merely acted as a powerful accelerating force in reversing the swing of the educational pendulum which had been moving against substantial secondary mathematics but was, perhaps, on the point of swinging slowly backward. For many years I have been noticing favorable signs leading me to think that this pendulum was about ready to stop its contra-mathematical motion. I have observed some of these signs in the universities. In them, there has been an unmistakable and strengthening trend toward the stipulation of at least elementary college mathematics as a prerequisite in many fields which previously were non-mathematical. This trend was thoroughly established in spite of a tendency, perhaps justified in some respects, for universities to use more liberal or flexible entrance requirements. A trend toward prerequisites involving college mathematics could not help eventually creating a sympathetic tendency on the part of high school students to take substantial secondary mathematics. Also, in the universities, the trend toward the use of more advanced mathematics in the undergraduate work in the physical sciences has long run counter to the trend toward weaker high school mathematics. Of these two trends, the collegiate one, I believe, was distinctly the more powerful and hence would finally have aided in a reversal of the anti-mathematical trend in the high schools. Another pertinent feature of the pre-war stiuation was the fact that the unfavorable attitude with respect to substantial mathematics in the high schools was entirely inconsistent with the increasingly technical nature of industry and our whole American civilization. This was true from the standpoint of the intelligent citizens who did *not* go to college as well as those who *did*. Thus, many skilled workers in industry were in need of trigonometry, some solid geometry, and algebra long before we entered the war. I have long believed that a substantial industrial revival would help blow the lid off the mathematical storehouse which many of our intelligent high school students have been prevented from entering because of unfortunate curricular trends. The technical advances of our civilization automatically require emphasis on substantial high school mathematics, in peace or in war.

As a second observation about secondary mathematics, let me call attention to the fact that both dangers and advantages

may be expected in the post-war period as a consequence of present conditions. At this moment, mathematics has great prestige because it is one of the fields of learning most favored by the Army and Navy; at the same time, mathematics continues to receive the support of its old friends in industry, the sciences, and the professions. After the war, however, we cannot expect the Army and Navy to maintain their active support of mathematics in collaboration with the field of education. Hence, common sense dictates that all mathematical educators should beware of resting their case for the *future* too strongly on features of the present situation which are uniquely associated with an all out war effort. We should be alert to emphasize those characteristics of the wartime mathematical picture which have long term significance for the good of education. Also, we should avoid fostering unnecessary interpretations of existing conditions which could be harmful in the future.

One favorable present feature which I wish to point out is the general elimination of the system of reserving substantial courses in secondary mathematics for those students who are fairly certain that they will go to college later. Unfortunately, before the current school year, this system prevailed to a great extent in many high schools. In the past, too many people have been in the habit of attaching the label "*college preparatory mathematics*" to most of the substantial parts of secondary mathematics. Naturally, such a label encourages the inference that *even an intelligent student* should omit the courses if he is not going to college. I consider the specified label and the related inference to be educationally unsound and decidedly undemocratic. When the substantial courses are well organized as to content and are taught by qualified teachers, the subject matter can be defended as *more* important for some of the students who do *not* go to college than for others who do. As a result of this old label and the associated viewpoint, some of the high schools have been cheating many intelligent students out of their mathematical birthrights by not encouraging them to take the substantial courses in mathematics. In the case of the intelligent students who did not go to college, these courses not only would have been intellectually satisfying but probably would have been better preparation for industry or business than the courses taken in place of the omitted mathematics. For the duration of the war, all of the intelligent boys will probably take substantial mathematics in high school. At the

moment, we must do our best to have this action extended immediately to cover the cases of the intelligent girls. Then, after the war, we must endeavor to discard the label "*college preparatory mathematics*" and justify substantial mathematics for *all* students of proper intelligence.

As a final suggestion, I recommend that in the post-war period the field of secondary mathematics should adopt a modestly aggressive attitude. It should be based upon new confidence in the ability of mathematics of all levels to serve the nation effectively in war or in peace, on recollection of the success attained by multitudes of citizens in learning and using mathematics during the war, and on refreshing new notions as to the content and objectives for the courses in mathematics. The achievements of mathematics during the present emergency justify the subject so clearly as a part of future general education, as well as of specialized education, that many contrary notions will have to be revised by the administrators of the secondary schools. In the post-war population, there will be a large nucleus of citizens who, through personal experience in the war period, have, for the first time, gained confidence in their ability to master and use mathematics. Another large part of the population, as a result of wartime curiosity, will have learned indirectly of the possibilities for the effective use of mathematics. I do not believe that these people will stand idly by if anyone should attempt to limit unduly the mathematical opportunities of pupils of the post-war period, unless they should be mistreated or improperly located in the courses which we shall offer to them. I do not anticipate a continuing eclipse of opposition to mathematics in the field of secondary education. However, as a result of the wartime experience of educators themselves, I hope that the future opposition will be essentially *constructive* rather than, as often in the past, *destructive*. Let us admit that the field of mathematics needs constructive criticism, because, even in the war period, some defects have appeared in the training offered by us at all levels in mathematics, up through major work in this subject in college. Hereafter, we should not take or allow others to take the attitude that the field of mathematics belongs to the teachers of mathematics and that their actions in its favor have selfish aims. Mathematicians should act as if it were their duty, as the delegated custodians of their field, to enhance its usefulness to the population by every possible means.

In conclusion, I shall quote a paragraph which I wrote some time ago for the report of my Subcommittee on Education for Service. This paragraph has been quoted[5] by the Chief of the Bureau of Navigation of the Navy in a letter to heads of state departments of education and administrators of elementary and secondary schools: "An emergency justifies any remedial action but our efforts should be directed toward making it unnecessary to use hazy emergency shortcuts to mathematical procedures. With our widespread democratic system of secondary and collegiate education, our nation is justified in demanding that we should *always* have on hand a relative surplus of people with mathematical training through substantial secondary mathematics and also a surplus with elementary college training in the subject."

[5] *Mathematics Teacher*, page 231, Vol. XXV; May, 1942.

THE EDUCATION OF WOMEN

Records disclose that the number of women attending college in the United States has increased more than 125,000 times during the past century. It is reported that by 1937 more than 500,000 were so enrolled. In 1837 the total number of such collegians was exactly four, enrolled at Oberlin College, and the first women to be admitted to institutions of higher learning in this couutry.

In breaking a precedent for the first time, that year Oberlin College announced that its door had been opened to "Young ladies of good minds, unblemished morals, and respectable attainments." Although none other of the fifty colleges of that day would admit women students, only four registrants responded.

Today there are 120 women's colleges and 80 men's colleges. Despite the early and continuing opposition to coeducation broken by Oberlin for the first time in 1837, there are now 451 coeducational colleges.

MEASURES OIL DENSITY FROM OUTSIDE THE PIPE

Measuring the specific gravity or density of oil or other fluids inside a pipe without making a hole in the pipe is the feat accomplished by the method patented (no. 2,304,910) by Donald G. C. Hare, Houston, Texas. It isn't as magical as it sounds. All that is necessary is to place near the pipe a source of highly penetrating radiation, gamma rays for example, that can penetrate the metal wall. Within the pipe the radiations are intercepted and partly scattered by the oil or other contents, some of them passing back out. Here they are picked up by a suitable instrument for measuring their intensity. From known scattering effects of oil at various densities and temperatures, previously determined by experiment and calculation, the readings can be translated in terms of conditions within the pipe.

ELEMENTARY SCIENCE THROUGH A VICTORY GARDEN*

Dorothy V. Phipps
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In these days of war, our country is looking to its citizens both in military service and on the home front for support. Each person has a part to play, whether he be old or young. Elementary school children of to-day will be the high school children of tomorrow. If the war continues for several more years they will have an increasingly important part to play in this might struggle for survival. Even now legislation has been passed by the state of New York allowing children of over 14 years of age to work on farms 30 school days a year. It is up to us as teachers of these very young to help them prepare to be of service to themselves, to their homes, to their community and to their nation.

One of the fields in which the elementary school child can contribute to the war effort is that of gardening. Food is becoming increasingly difficult to get due to the heavy demands on transportation and the lack of farm labor. The more food grown locally, the less will be the burden on the transportation system. I am thinking, however, not alone of the necessity for growing foods as near the source of consumption as possible, but also of the necessity for building physically strong and morally sound boys and girls who as they grow older will be prepared to take their places in the national efforts of good growing. Children who have never had a rake or hoe in their hands are of little use to the farmer, when called upon for labor on farms during vacation time. Let our own children be prepared to volunteer as many have done during the past year. Let us prepare them through actual contact with and practical handling of plants and garden problems, so that they will be able to aid in this most vital line of home defense, that of growing our nation's foods.

Ability in gardening comes with study and experience. We have no time at present for the trial and error method, nor do we have seeds to waste on impossible gardening situations. Let us therefore study gardening as a very enjoyable problem, yet

* Presented at the Elementary School Section of the Convention of the Central Association of Science and Mathematics Teachers, November, 1942.

as a problem that must be treated with scientific accuracy. Let us take it as part of our school work, not neglecting other subjects, but rather reinforcing them by integrating them with this important field. How can this be done?

That we may have before us, *one* way of organizing a school victory garden project, may I present a unit with which I was privileged to work in the 5th grade of one of our Chicago Public Schools?

The teacher and I, early in January, had thought that a garden unit was timely for these children, but hoped that the children, of their own accord, would ask to be allowed to have a garden. Early in February, after reading about foods in connection with their health program, a discussion ensued on how vegetables were raised. One child asked a pertinent question about gardening in Chicago, namely, "Can these vegetables we have read about be grown here?" After talking it over, the children decided it would be fun to try and see whether they could grow some of these vegetables they were supposed to eat. One child said, "Let's plant some spinach." When we asked if he liked spinach, he replied, "Not very much. Maybe it would taste better if I grew it myself." After discussing kinds of gardens, it was found that most of the children wanted to grow vegetables but a few thought flowers would be nice.

The next day we set aside a space on the black board for our plans. The children used the title *"Our Room Garden."* They listed the things they had found out about gardens from others, and things they knew themselves. The teacher asked for other ways they could find out. Finally a list of ways, including reading, experimenting, observing other gardens, talking with people who had home gardens as well as with professional gardeners and florists was drawn up and put on the board. The teacher and pupils brought to school all the books they could find on gardening and put them on a table called *"Our Garden Corner."*

Because time for the science class was very short, it was decided by the teacher to use the garden as the central theme as far as possible for the work of other classes. During the reading period the children read the garden books. Experiments, observations, planning and actual garden work was done during the science periods. Much of the actual garden labor also was done by groups either at recess time or when other work was completed. Drawing scale plans for the plots was given arithmetic time as was the measuring and laying out of the garden. Ar-

rangement of the garden considering color, height of plants, making of charts, decorating covers for garden notebooks all found a place in the art class. Correlating with social studies were the questions concerning the life of the farmer, where our vegetables come from, what transportation is necessary to bring the vegetables to our city, how and by whom they are handled when they arrive. The time devoted to English was taken by discussion of readings about gardening, consulting references, developing a gardening vocabulary, writing reports in notebooks of the progress of the garden and writing letters for catalogues. Although the school program was of formal type, the work in this room was integrated and correlated so that principles of each subject were brought out through the garden idea. In this way we were able to carry on a program that could not have been completed in the hour and a half allotted each week for science.

By reading and talking with people the pupils discovered that they would have many things to find out. The list of what they wanted to know included:—

1. Where they could have the garden.
2. What kind of soil the site had.
3. What flowers and vegetables they wanted to grow.
4. How much space each child could have.
5. What plants would grow best in the space each had.
6. What tools they would need.
7. When and how the soil could be prepared.
8. When the seeds should be purchased and planted.
9. How they should cultivate the garden.
10. What kinds of weeds would come up.
11. Would insects eat their plants and what could be done about it if they did.

By the end of February the class had located a small area on the school grounds which would be out of the way, have plenty of sun, fair soil, and which was near a source of water. The children had drawn plans of the garden plot to scale. Each group of two children was allowed a plat $2' \times 5'$. A space one foot wide was left between the plots to be used as a walk. Seed catalogues sent for several weeks earlier had begun to arrive. Vegetables and flower seeds were decided upon after much consulting with Mother, with books on health, with garden books, and of course with the teacher. Each child cut out pictures of the plants and pasted them on their garden plans to see how the garden would look when the seeds began to grow.

The class agreed to plant in their own plots, the flowers and

vegetables which would mature before school was out. In a room plot along the end of the garden they could plant those that would mature in the fall. Among the plants contained in the final lists were the following:—

Room plot	*Garden plots*
Sweet corn	Spinach
Peppers	Mustard
Parsnips	Peas
Onion seeds	Radishes, globe
Carrots	Onion sets
Petunias	Lettuce
	Turnips
	Swiss chard
	Corn salad
	Beets
	Parsley
	Dwarf Marigold

With the arrival of March, the class was ready to study the tools they would have to use. Through catalogues and trips to the hardware store, available tools were priced and compared as to value. A few children wondered whether farmers had other tools than the rakes, hoes and so on that they had seen. This led to reading about the way in which the farmer prepares for his field crops, how he threshes and how he gathers other crops such as corn, and cotton. Early tomato and pepper seeds had been planted in sand and humus in flats in a sunny location at the end of the corridor. These were to be transplanted later. Seeds were tested in the rag doll tester for viability. As the weather became more mild the great moment of laying out the plots and breaking the soil arrived at last. Older boys from the upper grades helped with the spading as the ground had not previously been broken. The soil was tested with litmus and found not to be acid, hence no lime was needed. A commercial fertilizer was added for good measure. The ground was worked down and made into good beds for the seeds.

Early in April, when danger of a hard freeze was over, peas, carrots, lettuce, onion sets, parsley, parsnip and spinach were planted. The class work in-doors revolved around what was happening to the seeds in the garden. Seeds were tested for starch. They were opened so that the tiny embryo plants could be seen. Others were planted against the inside of a glass tumbler, so that the children could see how the roots went down and developed and brought the cotyledons into the light where they turned green, shrank in time and finally fell off, but not before

the true leaves could take up their task of making food. The growing plants in the classroom were compared with those in the garden. It was found that in-doors, plants that did not have sufficient light grew tall and spindly and turned toward the light. The plants growing out-doors, on the other hand were sturdy and straight. Records were kept of the progress made by plants in both growing situations. Bulbs were studied and the advantages of planting bulbs were compared with those of planting seeds in such plants as the onion. The children learned that certain parts of plants were used for food but that the edible parts varied with the different plants. The temperature and sky were watched anxiously for the likelihood of frost or rain.

Early in May, bush beans, beets, carrots, radishes were transplanted and protected from the frost or too severe drying winds. Later came the corn and the transplanting of the peppers. About this time, the children had noticed that plants were growing between the rows of vegetable seedlings and that not all of the tiny plants in the rows looked alike. Of course, weeds had come into the garden. This led to a study of why some plants were called weeds and others not; why weeds were so successful; how we could prevent them and destroy those we couldn't prevent. Among the weeds found were dandelion, wild mustard, wild lettuce, lamb's-quarters. Clover and grasses were also seen. About the same time ants, beetles, larvae of many insects began to be discovered. The identifying structures of the insects found in the garden were studied, the social organization and colony life of an ant hill near the garden was observed and the life cycle with the eating habits of the insects found were observed and looked up in reference books. A few butterflies visited us. After spring rains, robins were seen to pull earthworms out of the garden soil. It was well into June, when we decided most of our vegetables were large enough to pick. A vegetable salad of lettuce, radishes, and other greens was served in school, the children declaring with pride that vegetables were really very good when they came fresh from the garden.

At the end of June the vegetables in the group plots had all been taken home for eating. A group of children who lived very near the school volunteered to take care of the room plot during the summer.

I wish that this experience could have had a happy ending by having a fall exhibit of fine vegetables from the room plot. On the contrary, however, the opposite was true. When the chil-

dren came to take care of the plot they found the school gate locked and when school began in the fall, the entire garden had disappeared. Workers had removed the whole thing and filled the yard with gravel!

Some of the outcomes of the gardening experiences were:—

1. The healthful outdoor exercise helped to develop muscles and appetites.
2. An intense interest in gardening was developed by the majority of the children, many children beginning gardens of their own at home.
3. An increased interest in the use of vegetables in the diet ensued.
4. An increased appreciation of the work done by another group of citizens, the farmer, was observed.
5. A partial appreciation of the amount of labor and knowledge that are necessary to grow the food that is bought so easily at the store, developed.
6. The beginning was made of a preparation that would aid in later years if the children are called upon to help in farm work.
7. A start, through a series of experiences, was made toward an understanding of a few science concepts such as:
   a. The interdependence of plants and animals including insects, worms, birds, and people,
   b. The life cycles of certain insects and the habits of insects, worms, and some birds,
   c. The value of plants as a source of food,
   d. The growth needs of plants and their responses to environmental conditions,
   e. The relationship of weather and climate to plant growth,
   f. The scientific method of problem solving.

Experience in helping with the organization of this school garden and other gardens in the city leads me to offer the following suggestions:

1. Let children plant only flowers and vegetables which will mature before school is over unless both the gardens and the work of the children are supervised during the summer session, by responsible older children, or adults. It is better to transplant plants to the home garden than to have the school garden go uncared for during the summer months. Enthusiasm attained through group work often leaves young children when they are on their own.
2. The taking of photographs, before and after gardens are grown, adds interest, especially for home or victory gardeners. These may be exhibited in school early in fall.
3. Fall flowers and vegetable exhibits promote interest among the children.
4. Victory gardens where parents and children work together or where many people in the neighborhood are working help to keep up the child's enthusiasm begun in the school.
5. Extremely poor soil that has had most of the top soil removed or has been serving as a dumping place for the neighborhood is found in many vacant lots in Chicago. It is a waste of effort, time, and seeds to attempt to grow a successful garden here unless new soil is brought in. This is usually too expensive to be practical.
6. Attempts to grow vegetable gardens in very shady places are usually

so unsuccessful as to make such a situation undesirable. Shade loving plants should be chosen for these areas. Careful study should be given to the adaptability of seeds to the situation at hand.

7. Use fresh viable seeds. Figure quantities carefully.
8. Locate the garden as near the school as possible, or better still, on the school grounds. If children are gardening outside of school, have them choose garden sites very near their homes, in their backyards, or use window boxes. If the garden is where the child sees it often he will be more likely to give it more continuous care. The early enthusiasm often wanes when too much of an effort must be put forth. The efforts of going a few blocks to work is often one hindering factor. Forgetfulness is the other.

The project cited in this paper was carried on during one semester only. To develop increasing ability in this field some gardening should be done each semester. It is our hope that gardening may become an established project in the schools of today as one concrete way in which children may be prepared to serve for the vitory of our country and the peace to follow.

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HEALTH FILMS

For the first time since 1924 the health film resources of the United States have been comprehensively surveyed, and the results have just been published in a pamphlet entitled "Health Films." It contains a descriptive list of 219 selected motion pictures, arranged under 38 subject classifications. Publisher is the American Film Center, a non-profit educational organization, supported by a grant of the Rockefeller Foundation.

This list is intended to help health educators, teachers and others to find the films they need, and is of special interest at the present time when the teaching of health has become more than ever an important national concern.

The pamphlet should be of assistance in bringing into wider use the existing resources in this field, and at the same time, by revealing the lack of pictures on certain important subjects, it should have an additional value to health educators and film makers as a guide to future productions, according to the introduction by Dr. Adolf Nichtenhauser of the Film Center.

"Health Films" is available at 25¢ a copy (lower rates for larger quantities) from Section on Health and Medical Films, American Film Center, 45 Rockefeller Plaza, New York City.

RADIO'S RELATION TO VICTORY

Lieut. Gen. J. G. Harbord
Chairman of the Board, Radio Corporation of America

The United Nations should look forward to 1943 as a year bright with promise in the war against the Axis. Here in the United States, after long, hard months of preparation, we are getting results scarcely believed possible a year ago. Millions of men are being equipped and trained in modern warfare. Our industrial capacity has been geared to a speed that will eventually overwhelm the enemy with its weight and power. With all its implications for final victory, this power should come into full force during 1943.

Real fighting is ahead. Wherever the battle lines are drawn, radio will be in the thick of the fight, for it is the lifeline of wartime communications on land, sea and in the air.

The war map today reveals that American soldiers, sailors and marines are lined up at more than sixty places on the world-wide fighting front. To unify them in communications is a mighty task. Without radio it would be a slow, almost impossible task. Every outpost, whether in jungles or on glaciers, no matter how remote, is linked to headquarters. American fighting men, almost a million of them, are focused in action by radio—the global lifeline of communications.

. . . . .

The road ahead to winning this war is rough. Every mile toward victory must be fought for with an all-out effort. The rapidity of the march, the turn in the tide of battle, hinge upon science and production, as well as upon direct combat with the enemy.

Science, through development of the electron tube, put radio in the fight and made it indispensable to the modern mechanized army, to the air corps, to the fleet, and to the merchant marine. Without the radio tube so wonderfully developed since World War I, radio could not play the important role it now has in warfare. The electron tube made radio equipment compact, portable, mobile, efficient and extremely dependable. That was not so with the cumbersome wireless apparatus that used the spark transmitter and crystal detectors in the first World War. It was not until the final period of the conflict that the radio tube began to find service in the Army and Navy.

Radio now qualifies as the voice and ear of the Army Signal Corps, of Naval Communications and of the Air Corps. We have but to look at the global war map to realize the great importance of radio. Its definite assignments and achievements necessarily are military secrets. But when we compare the present demands upon communications with those of the first World War, it is easy to understand that radio's present role is a thousandfold more important. The airplane, the world-wide transport problem, and blitz warfare, all of which call for utmost speed and efficiency in communication, have multiplied the demands and responsibilities of radio.

Within the past year—a year of tireless effort in the manufacturing plants—the men and women on the production front have given the American armed forces the finest radio equipment in the world. As the war rages into 1943, every American finds himself and herself linked in some way with the battle. There must be no let-up on the home front. Every day in the New Year must find production rushing full speed ahead to the battlefronts. Then, and only then, will the last battle end in our victory.

HIGH SCHOOL SCIENCE AND MATHEMATICS IN RELATION TO THE MANPOWER PROBLEM

A REPORT OF THE COOPERATIVE COMMITTEE ON SCIENCE TEACHING

Under present conditions of wartime stress and urgent preparation for a still greater struggle no one can live and prepare for the future as he would under normal world conditions. Instead of training young people for peacetime conditions we are forced to prepare them to withstand the rigors of war. Let us give them the type of training that will best fit them for the present struggle but at the same time will prepare them in so far as possible for citizenship in a world of peace after the war. To assist the schools in meeting these needs a study of the most essential adjustments in the high school work has been made by the Cooperative Committee on Science Teaching. Their suggestions are given in the pages that follow.

The committee is composed of two members from each of five national organizations: K. Lark-Horovitz and Glen W. Warner representing the American Association of Physics Teachers, B. S. Hopkins and Martin V. McGill, the American Chemical Society, A. A. Bennett and Raleigh Schorling, the Mathematical Association of America, Oscar Riddle and Walter F. Loehwing, the Union of American Biological Societies, and G. P. Cahoon and Robert J. Havighurst, the National Association for Research in Science Teaching. Robert J. Havighurst, The University of Chicago, is chairman. Copies of this report may be obtained from him.

CONTENTS

1. INTRODUCTION
   - Nature of the Manpower Problem As It Affects Youth
   - Proposals for High School Training
2. PHYSICS
3. BIOLOGY
4. CHEMISTRY
5. MATHEMATICS
6. SUMMARY AND CONCLUSIONS
   - A Policy for High Schools
   - The Preparation of Teachers

1. INTRODUCTION

High-school teachers of science and mathematics have been asked to train boys and girls rapidly and at once for technical jobs in the armed forces and in industry. For the duration of the war the older boys and girls of this country are expected to bear responsibilities which in normal times are reserved to adults. The work of their hands and their brains is needed in the armed forces, in industry, in agriculture, and in business.

The purpose of this report is to help secondary-school science teachers and administrators to analyze their part of the man-

power problem and to plan ways of meeting their important task in relation to the war as rapidly as possible.

Nature of the Manpower Problem as It Affects Youth

There are four major needs for the work of young people.

1. *Practical technicians for the armed forces and industry.* The Army is expected to increase from 5,000,000 men to 7,500,000 by the end of 1943. The Navy and the Coast Guard will also expand by several hundred thousand men. Practically all eighteen- and nineteen-year-old boys who can pass the physical examination will be inducted into the armed forces very soon. Boys of seventeen may look forward to induction shortly after they reach the draft age of eighteen.

General Somervell, who commands the Army Services of Supply, is authority for the statement that more than half of the enlisted men in our highly mechanized Army must possess some kind of technical knowledge and skill. The Navy requires even a higher percentage of skilled personnel. Most of the training required is practical rather than theoretical and of a type which can be obtained in a relatively short time. In this report such practical *technical* training is distinguished from *scientific* training, which is discussed later.

The Army is not now getting the number of men that it needs with these technical skills. It is especially short of machinists, auto and airplane mechanics, radio operators and repairmen, electricians, telephone and telegraph linemen and repairmen. Normally the Army takes men without any special training and sends them to Army Specialists Schools to learn Army jobs in a period varying from three months to a year. But with the Army expanding from 5,000,000 to 7,500,000 men within a year, the Army's training facilities will be severely taxed. In this situation, General Somervell has requested the civilian training agencies of the country to give as much pre-induction training of a practical technical type as possible. Through its Pre-Induction Training Section the Army has specified the kinds of pre-induction training that it needs.

The expansion of war industry, together with the induction of many trained workers into the armed forces, has created a severe shortage of workers with simple technical skills. Men and women are needed with approximately the same kind of elementary technical training that is needed by enlisted men in the Army.

2. *A continuous supply of scientifically trained workers for the armed forces and war industry.* Men and women with a thorough scientific and technical education are in constant demand for service and research on behalf of the armed forces. Physicists, meteorologists, radio engineers, all other kinds of engineers, medical personnel, are being withdrawn from their ordinary professional life to serve the armed forces. In order to keep a continuous supply of people with such training available, young men and women must be trained more rapidly and in greater numbers than ever before.

3. *A continuous supply of scientifically trained workers for civilian life and industry.* Chemists, physicists, engineers, biologists, doctors, are all needed as never before on the home front to keep war production and essential civilian activity going. With so many of these people now serving the armed forces, training of a continuous stream of young men and women for these positions must be maintained.

4. *Labor service of boys and girls in business and agriculture.* Civilian business and agricultural production are already limited by scarcity of workers. As experienced workers are drafted for war work, older boys and girls must fill the vacancies. Legal restrictions on the work of boys and girls are being lifted. Of the 3,350,000 boys and girls aged sixteen and seventeen now in school, probably half will be at work by next summer. Some will drop out of school, but most of them will probably take part-time jobs. The high schools may be expected to develop work-study programs which will permit boys and girls to work half of the day or week and study during the remainder.

The work done by these sixteen- and seventeen-year olds will be largely of an unskilled variety such as farm labor, work in offices, retail business, and other community services.

Proposals for High-School Training

High-school science and mathematics are needed by the young people who will help to meet the manpower needs described in the first three categories. Pre-induction training of a practical technical sort is needed by the great majority of boys who will go into the armed forces. Similar training is needed by girls who will go into industry as well as by boys who go into industry after failing to pass the Army physical examination. In addition, scientific education of a more thorough kind is needed by the boys and girls who prepare to meet the profes-

sional needs of armed forces, industry, and civilian activity.

Several proposals have been made for the development of wartime courses in physics and mathematics in the high schools. These proposals look toward supplementing the established high-school sequences in science and mathematics, which are taken by a minority of students. It is agreed that the orthodox high-school courses in physics and chemistry and botany and zoology, as well as the courses in advanced algebra and trigonometry are good preparation for further scientific work in college. The additional wartime courses are designed for students who are not now following the science and mathematics sequences. They are expected to help these students get sufficient technical and mathematical background to shorten the time that will be needed to train them for simple technical jobs after they are inducted into the armed forces.

A set of five pre-induction courses have been outlined by the Pre-Induction Training Section of the War Department and published jointly by the War Department and the United States Office of Education.[1] These courses are in elementary electricity, elementary machines, elementary shopwork, automotive mechanics, and radio. They are practical technical courses, emphasizing work with machines, tools, and electrical and mechanical devices. The three elementary courses are one-semester courses; the other two are one-year courses. These courses are the result of an analysis of Army jobs, which shows that a large proportion of enlisted men in the Army need a knowledge of elementary electricity, machines, and shopwork; and substantial numbers of men need more advanced knowledge in the fields of radio and of auto and airplane mechanics. In order to keep the terminology of this report clear, the term "pre-induction course" will be used only when referring to these courses which have been planned by the War Department. Other courses may be used for pre-induction training, but they will not be called pre-induction courses in this report.

An emergency physics course has been designed for students in the junior year of high school as preparation for more advanced physics or for technical courses. This procedure is being followed in Indiana, and will be described in the Physics section of this report.

[1] *War Department: Pre-Induction Training Courses. Fundamentals of Electricity; Fundamentals of Machines; Fundamentals of Shopwork; Fundamentals of Radio; Fundamentals of Automotive Mechanics*, Washington: Government Printing Office, 1942.

A war mathematics course is being developed under the auspices of the United States Office of Education which is somewhat analogous to the pre-induction physics courses but is not, at this writing, an official pre-induction course. This course is a one-year advanced general mathematics course, designed for fairly able students who have not pursued the mathematics sequence in high school and therefore cannot take advanced algebra or trigonometry. This course has been named the "Emergency Course in Mathematics."

Another type of mathematics course—an arithmetic refresher course—has also been suggested and is now in operation in Indiana. This course, of two periods per week for one semester, reviews mathematics that is usually taught in the elementary school through the eighth grade. It is provided for all students in the last two years of high school who fall below a certain level on an arithmetic screening test.

These are the principal proposals for wartime courses in physics and mathematics. The secondary schools are called upon to introduce some of these courses as a means of helping to meet the manpower emergency. Naturally, they want to make such changes as will be really useful. However, in the interest of efficiency they want to introduce these courses into the curriculum structure with a minimum of dislocation of existing courses. They want to make existing courses serve as far as possible.

In the following sections of this report, the committee has undertaken to suggest ways of reorganizing the science and mathematics program of the high school so as to achieve the immediate goals without unnecessary sacrifice in other areas. New courses are not proposed in chemistry or biology. But modifications and new areas of emphasis are suggested as means of making these sciences more useful in meeting manpower needs.

2. Physics

The technical developments during the last fifty years in the fields of transportation and communication, such as the new electronic devices in the field of radio, have everywhere stimulated progress in the field of physics on an unprecedented scale. Despite these scientific developments there has been a steady decline over a number of years in the teaching of secondary school physics. Though the senior high-school enrollment between 1890 and 1934 increased from 6 per cent to 54 per cent

of the age-group fifteen to seventeen inclusive, the enrollment in physics during the same period dropped from 19 per cent to 6.3 per cent of the total high-school enrollment.[2]

In normal times the lack of technical training of the high-school graduate has in many cases been made good by the vocational and trade schools directed by large industries in their own plants. For the small percentage going to college a scientific education has been provided on a somewhat higher level. However, the total number of men and women trained in physics was and is a small fraction of our population.

World War II has shown that a thorough training in the fundamentals of science and the mastery of its skills is a vital necessity for victory. In England, almost from the beginning of the war, an ever increasing amount of the national budget has been devoted to scientific education. The ingenuity of the scientists, inventors, and manufacturers of the United Nations has been able to develop in the time of a few months what the enemy has prepared for in years. But we are faced with a most serious manpower problem because we not only have to produce these devices for ourselves and our allies but we also have to man them and make them effective in an army such as the United States has never had before.

Laboratories engaged in war research require scientists with many years of academic training and practical experience. Scientific workers engaged in other fields have been recruited to fill this demand. Thus college faculties, government laboratories, and the laboratory staffs of private industries have been diverted into war research, depleting the normal reservoir from which to draw new workers and leaving many training centers with a fraction of their teaching staff.

Besides these professional physicists trained on the highest level there is a shortage of men and women trained on lower levels to maintain and operate the new devices and of men to fill the positions of technicians in the Army. Estimates of these numbers made by the American Institute of Physics run as high as 150,000.

Since the total output of physics majors in the colleges in normal years is less than 1,000 per year, it is clear that the shortage of men trained in physics which exists on all levels cannot be effectively dealt with by the colleges alone.

[2] United States Office of Education. Bulletin 1938, No. 6. "Offerings and Registrations in High School Subjects, 1933–34."

High Schools Must Commence Training Technicians

We are confronted with the necessity of using our secondary schools as the only other source for the technicians, operators and specialists which the Army needs. At least 50 per cent of the Army personnel requires some training in the physical sciences and related mathematics. A careful analysis of the Army jobs by the Pre-Induction Section of the War Department has shown that a particularly large number of men with a background in the fundamentals of mechanics, electricity, and of radio is needed.

The first problem facing us is the determination of the probable number of students in the secondary schools with an aptitude for physical science and mathematics. Physics and chemistry are usually taken in the eleventh and twelfth grade. The number of students enrolled in the physics course is about 25 per cent of the twelfth grade enrollment. It is doubtful whether this enrollment can be more than doubled and still deliver personnel which can in the end acquire a mastery of even elementary skills in the physical sciences.

We therefore recommend that the high-school population be screened according to their aptitude for work in physical science and mathematics. The Pre-Induction Section of the War Department has designated five areas as particularly important for the preparation of the future soldier. These courses, in electricity, machines, radio, shopwork, and automotive mechanics, are designed to prepare the student for a large variety of Army jobs. To provide the large numbers needed, the War Department recommends that every boy in the eleventh and twelfth grade should devote one or two class periods a day to work in pre-induction courses. Since all boys in the eleventh and twelfth grade are eligible to take this work, it cannot be too abstract or advanced but will have to stress practical applications. On the other hand, we have to prepare a large number for specialist training and we have to prepare women to be trained as technicians for the war research laboratories.

The numbers available for the academic courses and for the various emergency physics courses should be determined by the composite record of the results of an intelligence test, a mathematics and physics aptitude test, and previous school records in mathematics, general science, and biology. The science aptitude test should be given at the end of the tenth grade to provide

proper selection for the academic and pre-induction courses given in the last two years of high school.

There are several aptitude tests available at the present time. One, developed by Pennsylvania State College in collaboration with the Department of Physics of the University of Iowa, has been used widely in the state of Pennsylvania. Another one, developed at Purdue University by a committee of the Department of Physics and the Division of Educational Reference has been used by some schools in Indiana.

The outcome of such screening tests will determine not only the available number of trainees but also the number of teachers who must be trained for the increased number of students. If the number of students enrolled in the various physics courses is appreciably increased, we will face a serious teacher shortage.

New teachers will not be needed in the smaller schools because the physics teachers now engaged partly in other activities may be assigned to such additional physics classes as are created. It will be necessary, however, to train new teachers for the larger schools, particularly if the pre-induction courses in machines, automotive mechanics, fundamentals of electricity, and fundamentals of radio are to be given simultaneously with the regular courses of the schools.

With the draft age lowered to eighteen and the deferment rules rigorously tightened, it will be necessary to train a large number of women to take the place of the men gone into the armed services. These women will serve as teachers and as technicians for the defense laboratories. The screening test given at the high-school level will determine the number of girls who can take physics courses in the high school as preparation for laboratory technicians.

To determine which women can be trained as teachers a screening science aptitude test should be given to all women in women's colleges and at co-educational institutions of higher learning. It is realized that such a test will not effectively test the ability of the student as a teacher but only her ability to learn and comprehend physical science and mathematics.

We have now, three problems to discuss:

1. The preparation of teachers.
2. The wartime curriculum.
3. The development of teaching equipment for the new courses.

The Preparation of Teachers

The preparation of teachers may differ from peacetime requirements. It may not be possible to ask for a four- or five-year program. It may become necessary to develop a special program of a period from one to three quarters or semesters, depending on the background and training of the prospective teachers. Teacher-training courses in physics and mathematics may be subsidized in recognized training centers under the ESMWT program, a policy accepted during the last year by the United States Office of Education. The additional teachers fall into three groups:

a. Teachers in high schools with a physics teacher's license, but assigned to other subjects than physics. To reactivate this license we recommend a full-time program for one term in which the teachers will be trained in the content of the particular physics pre-induction or emergency course which they are to teach.

b. Teachers of neighboring sciences who have some previous preparation in physics. Same program as under *a*.

c. New teacher candidates with high score in aptitude test. They should be trained depending on their background in a two or three term full-time program in the fundamentals of mathematics, physics, electricity, and radio.

It may be necessary, if the emergency demands it, for teachers trained in such manner to leave the university without obtaining a degree. They should be permitted to return to the university after the war with full college credit for the work taken in preparation for emergency teaching.

For the training of these special teachers programs should be established in institutions of higher learning which still have a staff and facilities for this purpose. The question of subsidy of these teachers while in training and while teaching any emergency course is of utmost importance. Since the prospective science teacher is also a prospective employee for war industries, it may be necessary to subsidize his training period just as industries are subsidizing the training period of prospective employees.

In the ESMWT program the college instructor is compensated for teaching courses beyond his usual load. Extra pay for an extra teaching load may also be necessary to keep high school science teachers on the job.

Wartime Curriculum

Recognizing the fact that many topics in the customary physics course have little or no relation to the war effort, it is essential to analyze the present physics course from this point of view and to correlate it with the activities of the armed services. A procedure adopted in the state of Indiana indicates a possible solution. A committee representing institutions of higher learning and the high schools has been appointed by the State Department to analyze the topics to be given in the secondary school physics courses. The first part of an outline of an emergency physics course has been sent to all the schools in the state and contains:

a. Topics with reference by page and paragraph to each of the textbooks approved in the state of Indiana,

b. A list of lecture demonstrations to be carried out if possible with simple home-made equipment,

c. A description of simple student experiments,

d. A summary of the fundamental relationships involved in the unit.[3]

In every unit reference is made to the technical and field manuals issued by the War Department as they are related to the material under discussion. The course stresses wartime applications throughout and eliminates other material usually covered in a first-year course. Thus, in optics, geometrical optics is stressed as applied to the optical devices used in the army. In sound, the chapters on musical acoustics have been eliminated, but propagation of sound, depth sounding, sound ranging, etc., are discussed in some detail.

It is recommended that this course be given in the eleventh grade so that it can be followed by some of the advanced preinduction courses during the senior year. Offering physics in the eleventh grade is also desirable because a great many colleges are going to admit students with twelve high-school units instead of the customary sixteen units.

It is also desirable to integrate the high school physics courses with shop courses so as to make more use in physics of machines and tools.

It is essential that a new physics program of this sort be brought to the attention of the high-school administrators and

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[3] Copies of this outline may be obtained from Dr. C. T. Malan, State Department of Public Instruction, Indianapolis, Indiana.

teachers early enough so that they can adequately discuss it and prepare for it.[4]

Equipment and Priorities

Just as the content of the physics course must be analyzed, so it is also necessary to determine the essential amount of equipment.[5] Once this is done, it will be found that many schools do not possess the minimum essential equipment. The lack may be made up in electricity through assembling second-hand radio equipment which can still be obtained. By cooperating with the industrial art shops, in many schools excellently equipped for the ESMWT program, it will be possible to contruct and build a great many of the pieces of equipment necessary for demonstration and students' experiments. Wide use will have to be made of visual aids such as lantern slides or projection of figures from the Army technical manuals. In some cases it will be necessary to establish priorities of a similar rating as allowed for the ESMWT courses. In such cases a uniform procedure and general supervision should be established by the State Department of Education or some other state agency.[6]

It is assumed that each high school will appoint a counsellor to advise the school on the needs of the armed forces. This counsellor will be indispensable in the purchase of equipment where priorities are involved. A priority manual for ESMWT has been issued by the United States Office of Education and will guide the purchase of equipment for pre-induction courses.

Conclusion

The secondary schools are primarily the pre-induction centers for the enlisted men. They will provide the pre-induction training for most of the technically trained soldiers in our Army.

The secondary schools also begin the training of scientific

[4] In the state of Indiana a series of meetings was held in six counties with administrators and the teachers of science and mathematics. The whole program—screening test, teacher training and counselling, and the wartime physics and mathematics courses—was presented by representatives of the state department, members of the mathematics and physics emergency committee, and representatives of the colleges.

[5] A special committee, appointed last spring by the State Department, has done this job in the state of Indiana, setting up certain minimum essentials necessary to keep the physics course a laboratory course. Physics teachers interested in this procedure should write to Professor E. S. Eliot, Butler University, Indianapolis, Indiana, chairman, Committee on Equipment and Supplies.

[6] A counselling service for the mathematics and science war programs in the schools has been established by the joint efforts of the Engineering staffs of Purdue University and the Divison of Applied Psychology and Education. A similar procedure in other states will be of great service to orient the teachers in their new job and to keep them informed as to new developments and needs of the armed forces and war industries.

workers. To obtain the greatest efficiency in the production of specialists and highly trained personnel, a close correlation between pre-induction courses in the high school, college-preparatory courses, pre-induction courses in college, post-induction work in college, the Army schools, and the training in the Army Institute will have to be provided. In no other field is this as essential as in physics and engineering where continuity of training and correlation of topics could eliminate unnecessary repetition and duplication and lead in the shortest possible time to advanced training.

3. Biology

Apart from changes in subject matter incident to the war and post-war reconstruction biology, when well taught, contributes much that is vital to national and personal welfare. Courses in biology contribute to a rational view of life and living things; provide a background for comprehension of nutrition and personal hygiene; contribute the basic elements of agriculture and animal husbandry; constitute the prescribed prerequisite as well as the stimulus for entry into medicine, public health, teaching, research, and agriculture. In either peace or war these vital products and by-products should be strengthened despite necessary shifts in emphasis in particular aspects of biology.

Problems of food supply and nutrition threaten to become more critical during the progress of war and will probably continue to be vital in the immediate post-war reconstruction. The supply of farm labor, already seriously depleted, may in the course of war be still further diminished. In addition to direct effects of shortages in farm manpower the war already reacts unfavorably upon the maintenance and utilization of farm machinery. A continuous supply of recruits to medical and health services seems even more essential in war than in peace, and it is highly desirable that a supply of professional biologists be trained for teaching and for a variety of technical services. The foregoing considerations provide the background for an appraisal of the value of high-school biology in wartime, and they have a bearing on questions concerning the content of biology courses.

Since pre-induction training involves some new high-school subjects, it follows that, in general, trainees may have to drop one or another high-school subject. In any event, though some outright curtailment of the ordinary curriculum may become imperative, the immediate wartime importance as well as the

peacetime values of biology appear definitely to justify its retention.

The content of biology courses, however, perhaps should be altered in terms of war effort. Which shifts in emphasis seem desirable? Since the content of current courses in biology vary greatly from place to place a reply to this question can be made only in general terms. The courses now offered in some schools perhaps do much or all that wartime biology courses should do; but probably most schools should make some changes. The following statements suggest points for emphasis even though, for certain schools, this may not involve a shift of emphasis.

(1) The student should become acquainted with the not-too-elementary facts concerning the structure, functions, and care of the human body. Matters of first aid and hygiene are important in forestalling dangers resulting from neglect of minor injury. To every boy or girl this is useful in itself; it is essential to an understanding of nutrition; for prospective airmen it is a bit of basic knowledge; for soldier, factory worker, or agriculturist alike it affords some personal protection.

(2) The place of bacteria and fungi in personal hygiene, public health, water supply, and sewage disposal.

(3) The use of plant products in the production of food, clothing, shelter, medicine, plastics, and in fermentology.

(4) Genetics, and plant and animal breeding. Objectives and results achieved in disease resistance, hybrid corn, etc., with particular reference to increased production per acre and lowered costs of production per unit of plant material.

(5) Conservation of soil, forests, and grasslands in relation to wild life and flood control; new agricultural practices such as the planting of wood lots, close planting of certain forage crops, such as soy beans, as methods of weed control on farm lands.

(6) More attention to field work and applied ecology.[7] In this work there is need for careful planning of objectives and for testing to determine the achievements.

[7] The subject of teacher-training is not negligible here. The above list of topics for wartime emphasis well illustrates the importance of *broad* biological training for the teacher of high-school biology. Adequate training in subject matter on the college campus must now be sought from courses offered in four or five separate departments. Even then the especially desirable training in field work and applied ecology can rarely be obtained. To fill this need for in-service teachers special summer courses should be arranged and pursued, both at certain universities and at Lake and Marine laboratories. Groups of suitably trained biologists should participate in giving such courses, and large groups of teachers should attend them. It will probably be necessary to obtain federal or state subsidy for such courses if any large number of teachers are to take them under present conditions, when summer work provides much needed income for many science teachers.

Using New Developments in Biology

Biological training has proven of value in the war effort in certain important and, to some extent, unforeseen ways. These applications can employ the skills of both high-school youth and the experts. The participation of school children in food production in local victory-garden projects will become increasingly important in the war. Closely related to this type of garden work by high-school students is the production of drug plants, the supply of which from foreign countries has been cut off. Scarcities of belladonna, hyoscyamus, and digitalis exist, and production of these plants is very similar to ordinary gardening.

In addition to the foregoing activities to which students can contribute effectively, there are a number of uses for biology specialists in the war effort. Five handbooks of poisonous and edible plants are now being prepared for use of military personnel in each of the geographic areas of operations. Processing of natural camouflage for retention of foliage and color by means of certain so-called hormone sprays has enlisted the services of biologists. Other important uses of plant hormones involve the production of seedless fruits and the rooting of cuttings. The latter has recently been of great significance to the war in the propagation of cuttings from pine trees which produce exceptional quantities of turpentine; the cuttings can be rooted only by means of these rooting chemicals. Serious problems of food spoilage—of perishable produce in transit and storage—have developed needs for biologists with an understanding of such materials and the usual destructive micro-organisms. Need for skilled biologists in this area has increased commensurately with expansion in transport and the number of men in the zones of military operations. The technological use of fermentive bacteria and molds in production of alcohol and ethylene glycol from agricultural products, for use in explosives, synthetic rubber and plastics, calls for an increasing number of experts trained in a combination of biology and chemistry.

In the field of genetics one of the most important scientific and practical developments has been the production, by means of colchicine and other drugs, of true-breeding hybrid crop plants in which the normal chromosome number has been doubled. Many of the resulting true-breeding polyploids are already in production because of their superior commercial value and vigor. Future advances in this field will be of increas-

ing importance in agriculture. Other uses of biology in agriculture involve the production of American oil and fiber plants to replace foreign materials no longer available. Hemp, flax, or soy bean each yields a supply of oil, fiber, and seed meal in a single crop. Milkweed floss has proven a superior substitute for kapok and cork as an insulation material and for buoyancy in life preservers and aviators clothing. Milkweed floss is resistant to mildew, vermin, and to water because of its unwettable character and waxy coating. Perfection of liquid fertilizers for rapid results in increasing truck crop production and output per acre are important not only for the war effort but in permanent agriculture. These are but a few illustrations of new uses of biological subject matter which are essential in war.

Many of these topics can be made a part of regular biology and agriculture courses. Others can be taught in a course in hygiene.

4. Chemistry

World War I gave an unprecedented impetus to chemistry. Following the war, chemistry was popularized to such an extent that high-school enrollments in chemistry during the past twenty-five years have kept pace with the growing school population. During this period a steadily expanding chemical industry has required a constantly increasing supply of trained personnel varying in level from the routine analyst, whose education may have stopped at the high-school level, to the trained research chemist and chemical engineer with years of special preparation. High-school chemistry courses have been sufficiently attractive to materially assist industry in meeting its personnel needs in this field. Consequently, at the beginning of World War II there was an adequate, though not excessive, supply of chemists for essential and key positions. However, there are now serious threats to a continuous supply of chemically-trained personnel. Many routine analysts and technicians have been withdrawn from industry by Selective Service during the past year. Many college men have been diverted from a normal selection of chemistry as a major, and the eighteen- to twenty-year-old men, who might normally enter this type of work in industry, will not be available. It is therefore increasingly important that the high schools provide adequate opportunity and stimulus for the preparation of sufficient numbers of chemists, trained to meet critical needs as they arise in the

present emergency and in post-war adjustment and reconstruction.

The present high-school course in chemistry will require little change to make it effective as a basic course for meeting these needs. The chemistry teacher should teach more thoroughly certain carefully selected fundamentals of chemistry, together with applications most appropriately geared to war needs particularly as they affect his community. This may well mean that less ground is covered. There must be re-emphasis in some areas. The new emphasis may well be placed in five specific areas of application, as follows:

Chemistry and pre-induction courses. All boys will need an understanding of certain chemical principles for their post-induction technical training. These principles may be found through an examination of the War Department's pre-induction courses.

Chemistry and industry. Industry demands a supply of technicians and of research workers prepared for production and analytical work in electro-chemical and metallurgical operations. Our industrial economy, both in peace and war, requires a constant production of fuels, lubricants, fertilizers, plastics, rubber substitutes, and other materials. The high-school course in chemistry should be somewhat modified to meet the needs of local chemical industries, which may require considerable numbers of new workers, either women or men, assigned to this work as essential to the conduct of the war.

Chemistry and strategic materials. Chemists must assist in meeting unprecedented demands for the preparation and conservation of strategic materials. More than ever before the chemistry teacher must stress the conservation of natural and man-made resources. The requirements will be constantly changing. What may be strategic material today, such as rubber, may tomorrow be produced in such quantities as to make the natural sources no longer a vital factor. Again, as stock piles are consumed, what appears plentiful today may become vitally strategic tomorrow. Other materials, such as tin, are now, and probably will continue to be, strategic.

An effective understanding of the relation of chemistry to industry and to strategic materials demands a knowledge of the *geography* of chemical resources and of chemical industry. This might well include the location of raw materials from which metals and important chemicals are obtained and the location

of such energy sources as coal, petroleum, water power, and natural gas. In addition to knowing the actual location of essential chemical resources, it is important to understand the geographical relationship which determines the locating of chemical industries with respect to sources of raw materials.

Chemistry and biological applications. The present situation makes it imperative that all persons, whether at home in industry or in the armed forces, have a working knowledge of the scientific principles which affect their health and efficiency. Chemistry should supplement the student's knowledge gained in his study of biology as it relates to his choice of food under a variety of conditions, either on the home front or under rigorous warfront activity, and to his use of the principles of water purification and sewage disposal and the simpler principles involved in the effective use of antiseptics, drugs, vitamins, and the like.

Chemistry and agriculture. Agriculture is basic to the successful waging of the war and the winning of the peace. With a decreasing supply of farm labor and inability to replace farm equipment, the American people must make more effective use of the scientific principles involved in both plant and animal growth. They must be trained to use wisely those food products provided under a system of rationing. Of particular value is a knowledge of fertilizers, insecticides, and fungicides, and appreciation of the vast contributions of farm and forest products to insure a continued flow of plastics, alcohol, paper, and other organic products into our industrial and war machines. Such needs as these indicate clearly the importance of including the simpler principles of organic chemistry in the high-school chemistry course.[8]

Proposed Policies

With respect to the teaching of chemistry the emergency brings certain problems which must be considered in each school in relation to the local situation. One of these problems relates to the selection of pupils for the basic chemistry course. Shortages of teachers and laboratory equipment and chemicals may require more exacting entrance tests. Since chemistry and physics are generally considered as eleventh- or twelfth-grade

[8] Material for teachers dealing with these new topics may be prepared by the Committee on High School Chemistry of the American Chemical Society, whose chairman is Professor B. S. Hopkins of the University of Illinois. Teachers are invited to make known their interests in this connection to this committee.

courses, the Committee recommends that the same procedure be used in selecting students for each of these basic courses. A science aptitude test should be given at the end of the tenth grade with a view to guiding students who show special aptitude and interest in science into the basic course in chemistry. All boys whose records in science and mathematics and intelligence ratings indicate the ability to do good work in science should be encouraged to take a science sequence.

Records of girls should be studied similarly with a view to guiding them into courses in chemistry when their interests, their records on science aptitude tests, and other school records indicate that fundamental training in chemistry will enable them to do analytical and other routine work in industrial chemical laboratories (determined by local needs) or to enter training for nursing or other fields, such as home economics, in which a knowledge of chemistry is fundamental. High-school chemistry is a prerequisite for most hospital-training courses. Girls will find that a good training in high-school chemistry is a distinct asset in meeting the demands of the intensive nurses' training program, which during the emergency will be considerably shortened.

Five pre-induction courses involving fundamentals of electricity, radio, machines, shopwork, and automotive mechanics, have been outlined by the War Department. Mastery of these courses requires an understanding of many simple chemical principles. If the chemistry teacher does not teach these pre-induction courses, it will frequently be helpful for him to co-operate with the teacher of electricity, machines, and automotive mechanics in providing for the pupil correct and adequate training in the chemical principles and information considered fundamental. It has been suggested already that the chemistry needed in these courses should be stressed in the basic chemistry course. The chemistry considered fundamental to a mastery of these courses is as follows:

1. The chemical nature of fuels and the chemistry of combustion of all types of fuels.

2. The laws and principles involving matter and energy, as applied to the operations of engines and machines.

3. A working understanding of a wide variety of terms and concepts related to solutions and change of state in solids, liquids, and gases.

4. An understanding of the chemical principles and theories

that help to explain electro-chemical processes, with particular reference to the storage battery.

The development of special emergency courses in applied chemistry is not desirable. The needs for post-induction training in chemistry are too specific to be met effectively by general pre-induction courses.

In conclusion, it appears that American chemical industry must do more than supply the major part of the chemical needs of the United Nations during the war. In addition, American chemists and American chemical industry will have to aid in reconstructing and expanding the chemical industry of the entire world after the war as well as supply the chemicals needed during the reconstruction period. To meet this tremendous responsibility, high-school chemistry teachers must recruit and start the training of fully as large an army of young chemists as was being produced before the war.

5. Mathematics

There is a shortage in the mathematical training of the men who enter the armed forces. The military authorities are agreed on this point. Too often the time of men after they are in the Army is taken with learning decimal fractions, proportion, scale drawing, the measurement of an angle, the solution of a simple formula, and the like. This mathematics should be taught to boys and men before they enter the service, leaving to the post-induction period such mathematical elements as only the military organizations can teach or which they can teach better than high schools and colleges.

The problem confronting mathematics teachers is, "How can instruction in mathematics be modified, and that immediately, so as to aid on the manpower problem?" For the immediate future the crux of the problem lies in what can be done for the pupils enrolled in the eleventh and twelfth grades of the high school. The Committee wishes to call attention to three fairly well defined groups among these pupils and to make a specific recommendation for each group.

The Abler Students without Mathematical Background

This group consists of boys and girls now enrolled in grades eleven and twelve, with little or no systematic mathematics training beyond the eighth grade. Most of them are beyond the

sixteenth birthday, and there are few in the group who have more than three semesters to prepare for some sort of war service. This group is very large, including at least a million and a half in public and private schools and constitutes the most promising pool for meeting the mathematical needs of war activities. This group may be characterized roughly as having "missed the boat" in the sense that many opportunities to render war services appropriate to their abilities are now closed because they do not possess the required training in science and mathematics. What can the high school do for them?

Fortunately there is much that can be done for the more competent students in this group. *The Committee recommends that high schools provide immediately for this group a special "Emergency Course in Mathematics."*

Content of the course. There are some mathematical topics which can be taught to competent students in a relatively short period of time so as to open the doors to many opportunities in war activities. An inspection of the technical manuals used for training in the armed forces suggests that the following things should be emphasized in teaching such a course:

(1) The fundamentals applied to whole numbers, common fractions, and decimals.
(2) Direct measurement, including the significance of figures and the concept of tolerance and limits.
(3) Scale drawings, blueprints, reading of maps and graphs, indirect measurement.
(4) Important geometric relations, including simple constructions taught informally so as to gain understanding and conviction, and not by formal demonstrative geometry.
(5) Algebraic symbolism and its uses, simple formulas and equations, ratio and proportion.
(6) Per cents, particularly graphical applications and the use of the first case.
(7) The right triangle, and trigonometry applied to the right triangle.

To this list should perhaps be added certain optional topics that apparently lie in the debatable zone: (a) trigonometry applied to the scalene triangle, (b) logarithms and the slide rule, and (c) measurements of central tendency.

If the seven topics in the preceding list are carefully taught during two semesters with recitation or work periods five days a week, the competent students in this group will probably be

able to adjust successfully to any one of a great many post-induction courses.

The selection of students. Students admitted to the Emergency Course in Mathematics should be carefully selected to make certain that only those who can master these materials to a high level of competence without excessive strain and effort are admitted. To permit the Emergency Course in Mathematics to be a haven for slow-learning and dull-normal students would defeat the purpose of this course and would represent an indefensible waste of teacher energy.

The question arises: By what criteria shall this selection be made? In the larger schools teacher judgment based on the general picture of past performance of the pupil on school tasks supplemented by scores on a few standardized tests will provide an adequate basis. The Committee suggests that a pupil admitted to the Emergency Course in Mathematics should have an I.Q. of more than 100; he should have a score on a good reading test better than the median score of an eighth-grade class; and he should have a score on a reliable computation test in arithmetic higher than the median score of a seventh-grade pupil. In the smaller schools where the use of standardized tests does not seem feasible to the school officials, some selection can still be made. It should always be kept in mind that the pupil's ability to do a course with high satisfaction and fine competence is one of the most important factors in the selection of students.

Students with Less Than Average Mathematical Ability

This group consists of pupils who have relatively little aptitude and taste for mathematics. In general, they will feel insecure in mathematics either because they have been indifferent students and have never really understood the basic ideas or because of low competence in the fundamentals applied to whole numbers, common fractions, decimals, and per cents. Some of them may have had a few semesters of mathematics in high school, while others will not have pursued the subject beyond the eighth grade.

The Committee recommends that schools provide immediately a refresher course in mathematics for this group, meeting five days a week for one semester, and continuing the course for a second semester for such pupils as may need it.

Content of the course. The main goal of the course is to insure growth in the control of the fundamentals of arithmetic. How-

ever, it would be a very great mistake to limit the course to abstract drill. In all probability these students have had plenty of meaningless drill in earlier grades. The main difficulty for many pupils in this group is that they have never really understood the fundamental principles involved, and drill has been kept ahead of meanings. Therefore a goodly fraction of the class time should be devoted to teaching the meaning of the processes. Fortunately a good deal more can be accomplished with these more mature students than would have been possible in the same length of time in the earlier grades. If time permits, some of the topics suggested for the Emergency Course in Mathematics are excellent media for teaching the fundamental processes. For example, direct measurement is a graphic device for teaching the meaning of common fractions, decimals, and mixed numbers, and for motivating the fundamentals applied to these numbers.

In the refresher course there should be a systematic program for the growth of skills in the fundamentals but it need not be frozen to any special pattern of drill materials. It is further suggested that a refresher course to the largest extent possible should operate by individualized instruction, at least on the drill program, and probably also in the teaching of principles and processes.

Selection of students for this course. The Committee suggests that all pupils be given a reliable and comprehensive test in the fundamentals of arithmetic, including whole numbers, common fractions, decimals, and per cents, and that those who fail to make a score higher than the median for eighth-grade pupils be required to take this refresher course unless they qualify for the Emergency Course.

A widespread weakness in computation was revealed more than ten years ago by convincing studies[9] which showed that the degree of mastery of the control of fundamentals of arithmetic by seventh and eighth graders is very low and that there is little subsequent increase in ability in computation, even when we include college graduates.

The argument for reasonable competency in the fundamentals seems altogether clear. The technical manuals of the various military schools involve more arithmetic than one might guess. In a technical war the Army apparently cannot use many men

[9] Raleigh Schorling, "The Need for Being Definite with Respect to Achievement Standards," *Mathematics Teacher*, XXIV (May, 1931), 311–329.

to advantage who know nothing about arithmetic. Leaders of vocational education have long insisted on sound training in arithmetic for the industries. Even civilian life is getting more technical, and the rationing plans, especially the point system, will test to the limits the arithmetic of many citizens. For these reasons it would seem to this Committee indefensible for schools to fail now to take such steps as may be necessary to give the members of this group the arithmetic competencies needed.

Students Already in the Mathematics Sequence

This group consists of pupils in the eleventh and twelfth grades who have been taking sequential mathematics. In general, they will be able students, who are aiming at a professional career in mathematics or science or related fields.

The Committee recommends that students who are now enrolled in the mathematics sequence and are doing good work be urged to continue in such a course.

The evidence provided by military authorities seems to be completely convincing that students who have done well in four years of sequential mathematics in the high school are likely to fit into any one of a goodly number of post-induction schools, and that fragmentary materials taught in brief courses are not full substitutes for the standardized and rigorous courses of the traditional sequence in mathematics. On this point military authorities have spoken with great emphasis, and teachers of mathematics should be the last to abandon this position. Then, too, there is the need for rigorous mathematical training of a continuing stream of young men and women who are preparing for the scientific and technical professions.

Content of the course. There is room in many schools for improvement in the traditional courses in high-school mathematics. Obsolete material has been ejected from algebra and geometry courses very slowly. There are hundreds of high schools which have not yet modernized their courses so as to be in line with the spirit and letter of the report[10] by the National Committee on Mathematical Requirements entitled *Reorganization of Mathematics in Secondary Education*, published in 1923, not to mention the suggestions for new emphases in the more recent committee reports of the Progressive Education Associa-

[10] *The Reorganization of Mathematics in Secondary Education.* A Report by the National Committee on Mathematical Requirements. Published by the Mathematical Association of America, Inc., 1923. Pp. x+652.

tion[11] and the National Council of Teachers of Mathematics.[12] In many schools a first step in gearing their courses to the war effort might well be to compare their present offerings with the content recommended for algebra and geometry by the Committee of 1923. But even in the more progressive schools modifications of content to permit of more effective teaching and of the introduction of modern applications are possible.

The present situation presents teachers of mathematics with an excellent opportunity to motivate each of these courses by applications carefully chosen from war activities. In providing such applications, emphasis should be given to fields which have the greatest promise of permanent importance, such as aviation. Useful sources of problems and illustrations will be found in the various Army and Navy technical manuals and in pamphlets provided by state departments of education and other agencies.

Selection of students. Students who are encouraged to pursue the sequence courses for more than a brief exploratory period should be carefully selected as regards ability and aptitude. The trend toward increased enrollment in the advanced high-school courses in mathematics will no doubt continue. But teachers of mathematics should resist the temptation to build up heavy enrollments in the sequence courses. The majority of pupils should not be encouraged to take a four-year sequence in mathematics, particularly because their aptitude is not great and more especially because their expected future occupations will not make large mathematical demands.

Those responsible for the guidance of high-school students have an obligation in this connection. It is to give the student with more than average aptitude for mathematics the facts about the importance of mathematics in many vocations. He should realize that to the college student without mathematics many doors to opportunities are closed. Mathematical techniques are gaining emphasis in such fields as economics, sociology, business administration, and education. He is entitled to know that there are few subjects liked better by students than mathematics. In a recent survey by *Fortune Magazine*,[13] mathematics was the best-liked subject. But mathematics also received a high vote as the least-liked subject. Thus, many stud-

[11] Progressive Education Association. *Mathematics in General Education.* New York: D. Appleton-Century Co., Inc., 1940. Pp. xiv+424.

[12] *The Place of Mathematics in Secondary Education.* Fifteenth Yearbook of the National Council of Teachers of Mathematics. New York: Teachers College, Columbia University, 1940. Pp. xvi+254.

[13] *Fortune*, December, 1942, p. 8.

ents like mathematics very much, while many others dislike the subject. This and other considerations suggest that algebra and geometry as now organized and taught should be reserved for those who want to study them, who can do them, who like them, and who are going to make further use of them.

Suggestions to the Teacher

The content of all high-school mathematics courses will probably change under the impact of the war, with the introduction of military applications and illustrations. A few textbooks designed for wartime courses have already appeared and others will be published presently. Some of these will turn out to be of fine quality, while others will have been hastily assembled without careful consideration of the mathematical needs of war activities. The teacher can secure Army and Navy technical manuals and select his own military applications. But these technical manuals may not always provide a good criterion for deciding what mathematical things to emphasize in a high-school course. They have often been produced hurriedly and may not have been based on study of the actual mathematical operations required in military jobs.[14]

A report will soon be issued on the mathematical needs of war activities,[15] which will be based on a systematic analysis of the following character:

First, in how many post-induction manuals is the item used? How many persons need to learn it? (The first criterion, then, is the mathematics appearing in the manuals.)

Second, can the persons concerned with post-induction courses teach the item better than it can be taught in pre-induction courses? Do they prefer to teach it themselves? (The second criterion is the judgment of the experts teaching the post-induction courses.)

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[14] The need for caution on the part of the mathematics teacher in using current materials of this sort is illustrated by the following two documents, which appear in recent bibliographies and may have wide influence: "Mathematics for Pilot Trainees," Technical Manual of the War Department, April 22, 1942; and "Refresher Course in Fundamental Mathematics for Basic Technical Training," United States Naval Institute, Annapolis, Maryland, 1942. Critical study of these pamphlets indicates that they contain much material that is not based upon analysis of the mathematical operations actually performed in the technical jobs for which they are supposed to prepare men.

[15] On December 14, 1942, the Office of Education, cooperating with the various military authorities and with representatives of vocational education, appointed a special commission with instructions to make a special study of the mathematical needs of war activities and to prepare a report for guidance of high-school teachers of mathematics. The report of that commission will be published in the *Mathematics Teacher* for March, 1943.

Third, is the item something that high schools can teach, and does it open a good many opportunities either in industry or in military activities to the person who learns it? (The third criterion is the judgment of high-school teachers.)

Some Important Matters Ignored

The Committee has devoted itself to the teaching of mathematics in relation to the manpower problem and consequently has left untouched some important matters in the teaching of high-school mathematics. For example, it has said nothing about the importance of providing good substantial general mathematics courses for the high fraction of the ninth grade who cannot undertake a systematic study of first-year algebra. It has not discussed the social mathematics course that, when the war started, was just beginning to be developed experimentally in a number of centers for students in the eleventh and twelfth grades, and which was designed to provide the future citizen with such information as will give the family the maximum security for a given income. Such a course is undoubtedly as significant today as it ever was and will probably assume great importance at the close of the war. However, the Committee realizes that interest at the moment is in technical applications of mathematics and that it is therefore inopportune to press for a fair consideration of a type of mathematics course that aims to give greater social security by providing the student with information that would enable him to stretch the dollar by helping him to understand problems of installment buying, taxation, insurance, and the like. These and other issues have been purposely ignored in order to focus attention on the main problem now before teachers of mathematics.

6. Summary and Conclusions

High-school science teachers and administrators appear to have three principal responsibilities in relation to the manpower problem. The first is to provide a variety of courses suited to the abilities and previous training of various groups of high-school students and geared to the needs of the war machine. The second is to select and guide boys into the courses in which they can make their best contribution to the nation's manpower. The third is to recruit, select, and train girls for the work which they can do most effectively.

The willingness of high school personnel to meet these respon-

sibilities is attested by the changes which have already been made in response to requests of Army, Navy, and government officials for more and better training in science and mathematics. Recent studies made in the state of Indiana and in the Chicago area show that science and mathematics enrollments were substantially larger in the fall of 1942 than they were a year earlier. Physics enrollments increased slightly and in addition aeronautics courses have been introduced in a number of schools with an enrollment about one-third as large as the physics enrollment. Plane geometry shows an increase of 16 per cent in in Indiana, with no significant change in the Chicago area. Advanced algebra shows a 13 per cent increase in Indiana and a 10 per cent gain in the Chicago area. Trigonometry shows a 25 per cent gain in the Chicago area and a 90 per cent increase in Indiana.

These changes came in response to very general statements made last spring and summer about the nation's need for men with mathematical and scientific training. Now that manpower needs have been stated more clearly and more specifically, the high schools will really be put to the test.

A Policy for High-Schools

Differentiation of courses in physics and mathematics seems to be indicated. But new courses in biology and chemistry are not needed. The aim should be, in physics and mathematics, to provide appropriate courses for students who will work at jobs requiring varying levels of theoretical knowledge and practical skill. The manpower problem, as already indicated, is not only a problem of giving great numbers of boys a pre-induction training of a practical technical sort but also of giving smaller numbers of boys and girls a thorough scientific training leading to scientific work in college so that they may meet the continuing need for scientifically trained workers in the armed forces, in industry, and in other essential civilian activities.

In physics it is desirable to continue teaching a college-preparatory course to a small proportion of boys and girls, those who may expect to go on to college for scientific training. The pre-induction courses in fundamentals of machines and electricity may well be taught as simple, practical courses for the great mass of boys, who will be assigned to learn technical jobs when they get into the Army. While the outlines of the pre-induction courses issued by the War Department suggest a type of work which is not different from that in the college-

preparatory physics course it appears inevitable that the courses will be very much simplified for the large numbers of students who do not have special scientific ability or interest. In a large school with many classes of pre-induction physics, this difficulty could be avoided by sectioning students according to ability. The sections of students with greater ability would then really be taking college preparatory physics, except that the course would be concentrated in mechanics and electricity.

In mathematics the college preparatory sequence of advanced algebra, solid geometry and trigonometry should be taught to a small proportion of students. A new course should be specially designed to teach the mathematics necessary for technical jobs held by enlisted men in the armed forces. This should be a kind of advanced general mathematics. Finally, a refresher or review course in arithmetic might be taught to boys in their last semester of high school if they fall below a certain standard on an arithmetic screening test.

The proper selection and guidance of students must follow the establishment of differentiated courses in physics and mathematics. The Army and the Navy have both adopted the policy of sending many young men to colleges with orders to follow college courses designed to prepare them for advanced technical work of importance to the armed forces. Some of these young men will be trained for specific military jobs. Others will be trained as doctors, physicists, chemists, engineers, and may be sent into non-military work if the war lasts long enough and civilian needs become urgent. While in high school, these young men should pursue the orthodox high school college preparatory curriculum, with emphasis on science and mathematics.

It appears that at least 10 per cent and probably a greater proportion of the eighteen and nineteen year olds will be selected for such post-induction training in the colleges. Thus, at least this proportion of boys should be advised to stand by the regular college-preparatory science courses. The War Department suggests that 20 per cent of the boys in and out of school should follow "a war-applied course in physics and mathematics" as background for continued specialization at the college level.[17] When we remember that only about 55 per cent of the seventeen-year-old boys are in school, we see that at least 20 per cent and perhaps a larger proportion of high school senior boys should take college-preparatory science. The policy of giving all

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[17] See p. 3 of any of the War Department's Pre-Induction Course outlines.

boys only pre-induction courses of a practical technical nature would be a short-sighted one, for it would dry up the source of the continuing stream of scientifically trained personnel which is needed in war as well as in peace.

High school boys should be divided into three groups on the basis of general intelligence, score on a science and mathematics screening test, and school achievement in science and mathematics. One group of at least a fifth of the boys should be encouraged to take college-preparatory science and mathematics with the expectation of being sent to college for post-induction training. Another group will consist of boys who are equally intelligent as the first goup but who do not have scientific interests and have not been pursuing a scientific course. These boys should take the pre-induction physics courses and the emergency mathematics course with the expectation of getting minor technical jobs in the Army, where they will be valuable because they can learn rapidly. The remainder of the boys, about half of the high-school group, should also take pre-induction courses and the emergency mathematics or the arithmetic review course, with the expectation of using their knowledge in technical jobs. It should be remembered that about 45 per cent of the seventeen year olds are not in school. This group will, on the whole, be less suitable for skilled Army jobs than the group that remains in high school.

Women will become a more important part of the manpower reservoir as the war goes on. They will be more and more in demand as nurses, laboratory technicians, research workers, teachers, and factory workers. Girls in high school should be guided into appropriate vocational channels on the basis of the same kinds of information about their abilities as is used in guiding the boys. More girls should take biology and chemistry than have taken these courses in the past. The pre-induction shopwork course, and also the pre-induction electricity and machines courses should be open to girls who show some aptitude for work in these areas.

The small high school will have difficulty in meeting the need for differentiated training of students with various abilities. The school with only one class in physics and none in mathematics beyond plane geometry can hardly be expected to develop a battery of new courses for the small numbers of students who would take them. And the small school which does not offer physics at all—there are several thousand in the United States—does not have equipment for the pre-induction courses. The

science teacher in a small high school may well take an intensive course next summer to prepare himself better for the pre-induction courses. If he has only enough students for one class he can give extra attention to boys who show special promise. He can perhaps hold an extra class meeting a week for such boys, teaching them the more difficult things which he must omit for the bulk of his students.

Still, however much the faculty of a small school work to develop a varied program, they will fall short of what the larger school does. But the small school can concentrate on shop training if it has a vocational agriculture course, and it can prepare more boys for efficient work in agriculture. Thus there may be a rational division of labor between the small and the large schools which places just as great responsibility for meeting manpower needs upon the one as upon the other.

The Committee believes that it would be unwise to offer new wartime science or mathematics courses below the eleventh grade. Biology, where it is a tenth- or ninth-grade subject, and general science should continue to hold the places they now hold in the curriculum. They may, of course, be modified in content to take account of war needs and war applications. These courses are essential parts of the general education of all boys and girls, in war as well as in peace. Another reason for limiting wartime courses to the eleventh and twelfth grades is that a tenth-grade course, in which the students are mainly fifteen years old, can hardly affect the Army or industry for three years or more. Present national policy appears to favor making a maximum effort in the training of young people who will serve in the armed forces or in industry during the next year or two.

The curriculum changes which are now taking place in the upper years of the high school should be regarded as temporary. These are emergency changes. No pattern for a permanent curriculum is likely to be found in them. Yet the experience of adapting science and mathematics teaching to the needs of immediate practical and fateful action should prove invaluable. Out of this experience, though not out of the emergency curriculum pattern, may come vital ideas for the improvement of postwar science and mathematics teaching.

The Preparation of Teachers

There is definitely a scarcity of physics and mathematics teachers, while the number of chemistry and biology teachers

barely meets the demand. Any further increase in enrollment in high-school physics and mathematics will require more teachers in these areas. It is clear that there will be a further increase in enrollment, both in physics and mathematics.

The committee estimates that enrollments in college-preparatory and pre-induction physics courses will at least double and possibly triple the present physics enrollment. In mathematics, the enrollment in trigonometry may triple while the enrollment in advanced algebra may double. In addition, the new emergency course in advanced general mathematics will draw a large enrollment.

From this analysis, it appears that more of the schools' teaching time will have to be devoted to mathematics and physics. The smaller and medium-sized schools, with enrollment under 1000, will be able to handle the anticipated increase by assigning teachers now teaching mathematics part time to full teaching loads in mathematics, and by assigning physics teachers now teaching part time an increased amount of physics teaching. The larger schools will need new teachers of physics and perhaps a smaller number of new teachers in mathematics. There are 1700 high schools with enrollments over 1000. Estimates of the number of new physics teachers needed in these schools run from 1000 to 3000.

Where can the new teachers be obtained? It is a responsibility of the State Universities and of the large independent universities to recruit and train people for these jobs. But the teachers colleges and liberal arts colleges can also do a great deal to meet the need. The institutions of higher education as well as state departments of education may have to make temporary adjustments in requirements for majors and for teachers' certificates. Emergency action is needed.

Fundamentally, the problem of securing enough high school teachers of science and mathematics to meet emergency needs is the problem of paying them enough to attract them. The young people who might qualify for such positions can now get pay for learning a technical job in industry and can draw wages higher than teachers' salaries as soon as they learn their jobs.

The most powerful lightning strokes—those that split trees, shatter buildings, and create terrific noises—if they could be converted to usable electrical energy and sold at the usual rate would be worth less than half a dollar a dozen.

—*Westinghouse Research*

NOTES FROM A MATHEMATICS CLASSROOM

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(*Continued from the January issue*)

37. Finding an Average. When negative numbers are first introduced the text points out how they are used to represent opposite ideas, such as going up and down in an elevator, the rise and fall of stock prices, and so forth. There is another important application which is mentioned in few algebras, namely, the use of directed numbers to find averages.

Ask anyone (try some teachers of ninth grade algebra) to average five numbers, as 87, 92, 75, 81, and 88, and in most cases he will add the numbers and divide by five. But a person who is not timid about using signed numbers will estimate that the average is, say 85, and then find the average of the differences: $+2$, $+7$, -10, -4, $+3$. This average is $-\frac{2}{5}$; hence the average of the original numbers is $84\frac{3}{5}$.

When explaining this method to freshmen I find that they see the correctness of the method if I write the numbers as in the first three columns below. The average of the first column will then be the average of the second column, which is evidently 85, plus the average of the third column. However, when the method is actually used, much written work can be saved by arranging the work as in the last three columns, putting positive and negative differences in separate columns.

$87=85$	$+2$	87	$+2$	
$92=85$	$+7$	92	$+7$	
$75=85$	-10	75		-10
$81=85$	-4	81		-4
$88=85$	$+3$	88	$+3$	
$?=85$	$-\frac{2}{5}$			

Teachers who have had courses in statistics are familiar with the method. In Otis's texts on statistics the method is called averaging by ***substitution***. School executives have also overlooked the possibilities. In an article published in the *Bulletin of the National Association of Secondary School Principals*, May 1942, I showed how this idea could be used to decrease the work needed to find the averages of high school graduates.

The method is also interesting historically. According to one story, the signs + and − were used in the fifteenth century in German warehouses to indicate whether the weight of a chest or bale was over or under a fixed standard, a weight of 502 lb. being marked $+2$, and a weight of 497 lb. marked -3.

38. Other Uses of Negative Numbers. We are all inclined to search for applications of our subject that may confront the pupils after they leave school, and often we overlook the applications that a pupil can make while he is still in school or still in the algebra class. After explaining how useful negative numbers can be, we even try to dodge them.

Thus when solving $3x+4y=6$ and $7x+5y=1$ many teachers would have the pupils multiply the first equation by 5, multiply the second equation by 4, and then use subtraction. But a pupil shows that he appreciates signed numbers when he multiplies the second equation by -4 and then adds. Here is a use for negative numbers in the algebra class; the pupil does not need to wait until after graduation to begin using them.

Again, when solving $3x-4y=23$ and $4x+3y=14$ by the substitution method, most teachers would be disappointed if the pupil solved the first equation for y. But a pupil shows that he is not scared of negative numbers if he writes

$$y=\frac{23-3x}{-4} \quad \text{and} \quad 4x+\frac{3(23-3x)}{-4}=14.$$

He will next use -4 as a multiplier to clear of fractions; and why not? Is not -4 just as respectable a number as $+4$? We might say that the work will be easier if the pupil solves the first equation for x instead of for y. But if this is really easier, it is because the pupil has not become accustomed to negative numbers.

As a third example, consider solving $-3x^2+2x+8=0$ by the usual formula. Many teachers would think that the pupil should first change the signs of the terms so that the coefficient of x^2 becomes positive. But a pupil shows that he is not scared of negative numbers if he does not change the signs. It is true that he will get a negative number in a denominator, but he is supposed to have learned how to divide by a negative number.

There are many other places where the pupil could be confronted with negative numbers. We could for example, have more equations in which the root is negative, and in our drill on factoring we could have more quantities like

$$-x^2-xy+6y^2, \qquad -x^2+5xy-6y^2.$$

The pupil may rearrange the terms of the first quantity but what will he do with the second? He should proceed as usually, writing $-x^2-xy+6y^2=(-x\quad)(x\quad)$.

39. Solving Pairs of Linear Equations. About ten years ago at a meeting of the Men's Mathematics Club of Chicago we discussed and voted on the question: If only one method of solving sets of linear equations is to be taught, do you favor the substitution of the multiplication-addition method? The vote was about 5 to 2 in favor of the latter. If a vote were taken to-day, the result might be different.

Ten years ago this topic was usually placed at the end of the first year's work. Now it comes during the first half of the year because teachers have found that the work of solving problems can be greatly lessened by using sets of equations instead of restricting the pupil to a single equation. The nature of the problems is such that the equations are like:

$n+d=13$	$x=y+5$	$l=3w+4$
$5n+10d=95$	$2x+3y=160$	$2l+2w=88$

For such pairs the substitution method seems natural; one of the equations is either already solved for x or for y, or a mere transposition tells what x or y equals. From his work on formulas the pupil is accustomed to substituting 5 or 6 or -2 for a letter; now he substitutes $y+5$ for x. There is very little new to learn.

If the verbal problems led to such pairs as

$$2x+3y=10 \quad \text{and} \quad 5x-4y=13$$

there would be some reason for beginning with the multiplication-addition method. If we do not use problems to motivate the study of the equations but plunge directly into the solving of equations, we would have another reason. But since neither of these things happen, the substitution method seems the desirable one. Further, we should not overlook the fact that substitution is a fundamental operation like adding, multiplying, transposing, while the multiplication-addition method is just a trick and should be listed among "short cuts." I admit that the below-average pupil makes fewer mistakes with the multiplication-addition method; but rather than adjust algebra to the weakness of the pupil, I would adjust the pupil to the realities of life.

40. Rules Versus Intelligence. After the class has learned to solve sets like $x+y=10$, $2x+3y=5$ by the substitution method, it may well continue with that method and use it to solve sets like

$$4x+5y=19, \qquad 5x+3y=11.$$

After this method has been well learned, the other method may be introduced. A second method always needs justification and motivation. Sometimes the second method is shorter. But the real reason for learning it is this: When several methods are available we have an opportunity to practice *thinking, analyzing,* and *selecting,* whereas previously we blindly followed a rule. Further, the best results are often obtained by combining several methods.

After the class has learned both methods I give a test in class using equations like the following:

1. $4(x+y)=48$
$5(x-y)=40$

2. $x+y=10$
$3x-4(x+y)=x$

3. $\frac{1}{2}x+\frac{1}{3}y=6$
$\frac{1}{2}x-\frac{1}{3}y=2$

4. $2x-3=\frac{1}{2}(x+y)$
$-7=\frac{1}{2}(x-y)$

5. $x=y+2$
$\frac{1}{3}(x+y)=\frac{1}{3}(x-y)+4$

6. $x-5=\frac{1}{2}(x+y)$
$x=13-\frac{1}{2}(x+y)$

On the previous day I have told the pupils that the equations will be specially fabricated ones so that they can be solved quickly, almost at sight, provided they use some clever ideas and do not follow the usual rule of thumb methods. This is a test of whether the pupils follow rules blindly or use intelligence.

For example, in ex. 1 the pupil should not multiply by 4 and 5 to eliminate the parentheses, but should divide by 4 and 5, getting $x+y=12$ and $x-y=8$.

In ex. 2 he should not solve the first equation for x or y, but should substitute 10 for $x+y$ in the second.

In ex. 3 and 4 he should not clear of fractions, but should add at once.

In ex. 5 a pupil may be tempted to use substitution but a bright pupil will see that the second equation is $\frac{2}{3}y=4$.

In ex. 6 adding the two equations gives $2x=18$.

Thereafter the pupil may not *think, analyze, select,* but he knows that such opportunities exist.

HIGH SCHOOL CHEMISTRY PROVES ITS WORTH

John Rosengren
State Teachers College, Jersey City, New Jersey

The value of a high school chemistry course for students planning to go to college has been sharply challenged, particularly by college chemistry teachers who prefer to teach rather than reteach poorly prepared students. In the fall of 1941 two classes in college chemistry were started at the Jersey City State Teachers College. In one class we placed all students with a high school chemistry background while those who had no previous experience in chemistry were placed in a separate class. The students with one exception were college freshmen, who had passed the same college entrance examination. The one exception was a student with sophomore ranking.

There were sixteen students in the group which had had high school chemistry and fifteen in the group which had had no high school chemistry. Of course, we realize that the number of students is not large enough for conclusive evidence, but the opportunity to compare their chemical knowledge at the end of their school year was irresistible.

Both groups were taught by the same teacher. Both groups had one three hour laboratory period and three one hour lecture-recitation periods each week. Both groups worked on qualitative analysis during the last two months of the course. The two groups used different college chemistry texts and laboratory books but the subject matter was practically identical. The only difference between the groups was that it was found necessary to help many of the group who had not had high school chemistry with simple arithmetic once a week for a period of several months. This deficiency in mathematics probably explains why they had not selected chemistry in high school.

After a few weeks, the teacher discovered that two of the students he had classified as being novices, actually were masquerading under false colors. Although they had studied chemistry in high school they had enrolled in the unprepared group because they felt this would give them a decided advantage in their class ratings. Their schedules would not permit them to be transferred to the other group so they continued to the end of the year with the non high school chemistry section. Their chemistry test results are therefore tabulated with the group

which had had high school chemistry and the results marked with a star to differentiate them. This made the number of the two groups eighteen and thirteen respectively.

To test the two groups impartially it was decided to give both groups the Cooperative General Chemical Test Form 1942 for college students, prepared jointly by the Cooperative Test Service and the American Chemical Society, through its division of chemical education. The test was given at one time to both chemistry sections at the end of their year of college chemistry and corrected by the key furnished by the Cooperative Test Service. The following table gives the raw score and the percentile score of each student as checked against the results from one hundred and thirty-one colleges in which the test was administered to 7887 students.*

CHEMISTRY TEST SCORES

High school chemistry plus college chemistry			Only college chemistry		
Student	Raw score	Percentile	Student	Raw score	Percentile
A	129	86	a		
B	111	75	b		
C	104	69	c		
D	104	69	d		
E	99	65	e		
F	91	58	f	95	62
G	89	56	g	85	52
H*	84	51	h	73	40
I*	82	49	i	64	30
J	79	46	j	60	26
K	79	46	k	59	25
L	70	36	l	59	25
M	68	34	m	57	24
N	62	28	n	50	17
O	62	28	o	49	16
P	60	26	p	49	16
Q	59	25	q	41	10
R	28	03	r	19	01
	18)1460			13)760	
Arith. Mean	81.1 =	48 Percentile Rank	Arith. Mean	58.5 =	25 Percentile Rank

This table shows five students of those with a high school chemistry background doing better than the best of those who had no previous chemistry training. Another comparison would

* Final Chemistry Percentile Tables, August 12, 1942 of the Cooperative Test Service of the American Council on Education.

be to use the chemistry score of 7887 students in one hundred and thirty one colleges who have taken the same test as a measuring unit. This shows that eight out of eighteen students with high school chemistry preparation were in the upper half of the percentile score, while only two students out of thirteen with no high school chemistry preparation finished in the upper half of the percentile score. A third comparison of the two groups show the arithmetical mean to be 81.1 and 58.5 respectively or a percentile score of 48 to 25 as taken from the final chemistry percentile tables of the Cooperative Test Service of the American Council on Education.

This limited evidence indicates that a high school chemistry course enables the average student to do nearly twice as well in college chemistry as one who has had no chemistry previous to entering college. It also indicates that good students can rank with the upper group in college chemistry even though they have had no previous chemistry training, if only they apply themselves as these two students did. One student ranked in the 62 percentile and the other in the 52 percentile score. This result also indicates that high school chemistry teachers in our particular locality are doing good work in their high school chemistry classes. It would be interesting to conduct a series of comparative tests along these same lines with larger groups.

NEW INFORMATION ON MILITARY OCCUPATIONS

The Occupational Index, established in 1936 under a grant from the Carnegie Corporation, has just announced that in the future it will review, annotate, index, and evaluate all new publications on military occupations; including all books and pamphlets which describe the attractions and the disadvantages, the opportunities and requirements of all branches of the Army, Navy, Marines, Coast Guard, Air Corps, Waacs, Waves, and Wows, and the Service Projects for Conscientious Objectors. New subscribers will receive a recommended list of publications already available. The Occupational Index is published quarterly at New York University; the annual subscription price is five dollars.

Professor Robert Hoppock, in announcing the new service, said that vocational guidance for boys is becoming almost exclusively guidance for military service and that it promises to remain so for the duration. He predicted that school and college counselors would soon find their college catalogs and books on civilian occupations being pushed off the shelves by books and pamphlets on the new military careers. The new service, he said, is designed to help schools and libraries to find the best sources of information on any branches of the service in which their students may be interested.

A MODERN METHOD OF TEACHING SCIENCE

NORMAN R. D. JONES
South West High School, St. Louis, Missouri

Most science teachers urge their pupils to read papers and magazines and occasionally give class time to the discussion of a good article. Some have one day of the week set aside for clippings, articles, etc., to be read and commented upon.

Many times in class, when a good article had been reported upon, the writer remarked that he would like to have a course in which current science literature would be the chief source of material used.

To the knowledge of a number of prominent science teachers, to whom the question was referred, no one had ever tried out such an experimental course. Consequently when the assignment of a class, variously called Advance General Science, Senior Science, etc., was received for the second semester, fully realizing that the type of student (usually one who was afraid to take either chemistry or physics) would be below average and not the best for experimentation, permission was requested to try out such a procedure.

The principal, being a former science teacher and progressive, listened with interest to the proposed outline and after careful consideration decided that the idea was worth at least a trial.

The next step was to sell the members of the class on helping to carry through the idea of a group using only current science literature. The two things more than anything else which probably influenced their decision to carry on the experiment was that there would be no textbook (and it was a big one) to carry around and no final examination. A term paper on some subject of their own choosing was to be submitted instead of the examination.

Since newspapers and science magazines were to be the so called text, the pupils each brought in the previous day's newspaper and started looking for acceptable clippings. Numerous clippings were found on rubber, chemical substitutes and for St. Louis the smokeless coal problem. Many were rejected as not being science because they were more political, etc., than scientific. Eventually the majority of the class became proficient in determining clippings of scientific interest.

After exhausting the available material in the newspaper, the question was raised as to what periodicals could be used for

summarizing articles for class reports. A list was made of science magazines that the pupils found in the school library, newsstands, etc., which could be used without question as to scientific content. In order to use articles from any other magazines it was decided that the scientific content would have to be approved. The pupils also drew up a list of topics for their term papers and set the sixteenth week (there being twenty weeks to a semester here) as the date for requiring them to be turned in, first, so that they could have it out of the way when final examinations from other classes would be requiring extra time, and, second, so that there would be time for the better ones to be read.

Some of the class members were doing excellent work while others were not accomplishing much. Numerous discussions were held on procedures so after it was mentioned several times that assignments, amount of work due, etc., were too indefinite (a common complaint of all experimental classes) they decided to set up minimum requirements of work to be handed in, the day it was to be checked in and penalties for not getting the work in.

The schedule besides the daily newspaper clipping reports as determined was: Monday of even weeks, a progress report of work done on the term paper; Tuesday, newspaper clippings for the previous week (with a minimum requirement of one for each day) were handed in, the greatest number being 34 with about 15 as an average for most of the students; Wednesday, the weekly report from a current magazine was checked in but, as it was to be read to the class, was not turned in until Friday; an additional assignment was to be turned in on Friday of the "odd" weeks. These latter assignments included securing additional information on clippings, checking advertisements, testing of experiments suggested in advertisements, etc. Scrap books containing at least the clippings in a classified manner were turned in each grading period. While individual conferences were being held on term papers or other work, the rest of the class would be pasting material in their scrap books or doing further reading on various subjects.

The determining of procedures, evaluating of the work and discussion of possible changes, of necessity, was time consuming. However the opinion of practically the entire class was that the experiment was worthwhile, informational and appealed to their interest, and that courses of this type should be encouraged.

This plan of procedure is very commendable with much in-

terest being manifested by all. Each pupil had the opportunity of choosing topics on which he desired more information. Reading became a pleasure and newspapers something more than just a comic section or a sport page.

The greatest good from a class of this kind would be obtained from seniors who had already taken biology and either physics or chemistry. Their fund of scientific knowledge would thus be greater and a better understanding of the material presented in the various articles would be obtained. However the two in the class who had no previous science felt that they were well repaid for their time and energy expended.

A report of this kind would not be complete without some excerpts from unsigned statements turned in by pupils: "Interesting (on practically all papers); beneficial; different; improves knowledge of the present; teaches one to read the newspapers intelligently; one way of teaching science in a new and modern method and getting enjoyment out of learning; newspapers help to show how much science there is in every day work and play; reading things I never read before; chance to learn more than what is in a book and to express yourself in the way you see it; this class breaks the monotony of school; etc."

Naturally all could not be satisfied so a few comments were made against the course, such as: "Course dull at times; course indefinite; some reports are interesting but most are not; and too much time wasted in determining procedures."

The boy who did the least work and caused the most trouble made the surprising statement, "I enjoyed this course best of all because one learns to think for himself and to find out about scientific inventions and discoveries."

NEW TYPE CERAMIC GRATE TO BRING FIREPLACE BACK TO MILLION AMERICAN FAMILIES

Flickering flames of the fireplace will cheer at least a million additional American homes this winter because of ceramic grates, the WPB Conservation Division here announces.

Because of the ban on cast-iron grates, engineers were faced with the problem of developing a non-metallic grate. They came through with clays and other heat-resistant materials, fired and hardened at extremely high temperatures, which will save 30,000 tons of cast iron.

Fuel shortages have brought the fireplace back to many family circles. Wood, coal or charcoal may be burned in the new grates. By burning coal in the fireplace, substantial savings can be made in the fuel normally used, officials of the WPB Conservation Division point out, yet permitting an equal degree of comfort.

THE FORTY-SECOND ANNUAL CONVENTION OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

RAY C. SOLIDAY, *Secretary*

SEVERAL HUNDRED members and guests attended the 1942 convention of the Central Association of Science and Mathematics Teachers at the Morrison Hotel, at Chicago, November 26–28.

The surprisingly large attendance attested to the attractive quality of the program prepared by President J. S. Georges and his section officers. In the face of great uncertainty and increased burden of work by all teachers, an increased interest in improvement was evident. The entire Association is indebted to President Georges, section officers, local arrangement committees, and to all the speakers who participated in the program for their untiring efforts to provide the best possible program.

Many of the manuscripts presented at the Convention will appear in SCHOOL SCIENCE AND MATHEMATICS.

The customary Friday evening banquet was omitted from the program this year, permitting extended study of the exhibits at our own convention as well as attendance at the National Chemical Exposition or other points of interest.

After careful consideration of present conditions and possible future developments, it has been decided to plan for a 1943 convention, in Chicago, similar in scope and organization to that now being reported.

THE FRIDAY MORNING GENERAL SESSION

The Convention program was opened by Professor Ralph W. Tyler, of the University of Chicago, who presented an address on the topic, "The Role of Education in Our Present Emergency." Professor Tyler showed that if education is defined to include vocational training, it is obvious that a major task of the modern army is education. He also pointed out that vocational training in wartime is essential for large groups of civilians. All of us are concerned that three educational tasks be accomplished: namely, the training of military personnel, the training of civilian personnel for essential civilian occupations, and general education for good citizenship necessary now and in the post-war period. Science and mathematics instruction for purposes of general education is not being given thoughtful consideration during this war period.

Educational institutions are under pressure from many groups. Those interested in promoting inter-American understanding, the Office of Price Administration, the Civilian Aeronautics Authority, the Army Services of Supply, the school Victory Corps group, the ESMWT people, all of these and others are exerting pressures on the local institutions to adopt certain proposals and projects. Washington speaks with many voices and without authority. Governmental agencies may bring proposals to the attention of the local staffs but the acceptance or rejection of these proposals and the development of an effective coherent educational program is our task.

Professor Tyler showed that to supply the armed forces and civilian economy as we will have them by the end of 1943 will require, in addition to adult workers, about 4,000,000 workers drawn from the age groups below 18. He showed that most boys will have until 18 to participate in an educational program which is determined by the local school or college. He also pointed out that the shortage of professionally trained people is

becoming alarmingly serious and that these shortages cannot be repaired in a short time.

The responsibility for basic military training should and will be met by the Army. For the school to develop pre-induction programs which duplicate army training programs is a serious waste of educational time and effort. The schools must provide for the essential educational needs which will not be met elsewhere.

Professor Tyler suggested that the school take responsibility for combining a program half of work and half of schooling to meet the labor demand and still not deny the youth under 18 some educational opportunity. Liberal education will have to accept the responsibility not only to plan an educational program to meet emergency labor shortages but also to provide the best type of human being for military and civilian service to win the war and to make the good life after the war.

We must make a comprehensive plan for wartime education. The criteria for a good curriculum are as valid now as before the war. An educational program to be effective must aim toward common objectives, must provide for sequential development, must give opportunity for thought and action on the part of the student and must be well motivated, unified, and coherent. In our confusion of the past year, these criteria have largely been forgotten. We need to develop a truly effective educational program, for now we have no time to waste in education.

Professor Paul B. Sears, of Oberlin College, spoke on "The Role of Conservation in Our Present Emergency." He stated that the most important job of Civilian Defense will be the conservation of our natural resources; the air we breathe, the water we drink, and the soil. He described the cost of modern warfare thus; one shot from a naval gun requires a bale of cotton, which often is the result of a sharecroppers entire year's labor; the rubber in a tank will supply about sixty automobiles; and Oberlin's endowment would build one small cruiser. Professor Sears discussed how we in America have been shamefully wasteful of our natural resources. He showed that an undisturbed natural community of plants and animals reaches a balance and shows an increase in energy and materials. But most human communities destroy this balance and show a decrease in energy and materials. Thus man's civilization is built at the cost of the net accumulation of plants and animals. As illustrations of this we have our depleted forests, infertile New England soils, muddy rivers, decrease in fish supplies, loss of America's topsoil, dropping of underground reservoir of water, loss of petroleum and natural gas due to unbridled exploitation, etc.

He showed that it is the duty of every citizen to become acquainted with one's environment and to practice true conservation at all times.

Professor Walter L. Hart, of the University of Minnesota, spoke on "The Nation Calls for Mathematics." As a background for later remarks, Professor Hart outlined various mathematical features of the war effort. He pointed out why the present need for mathematics completely dwarfs the similar demand which arose during the war of 1914–18. He proceeded to discuss the nature of the present calls for mathematical instruction particularly as they affect the secondary level. Also, he mentioned certain dangers as well as advantages in the post-war period which may result from the wartime situation of secondary mathematics. Finally, he suggested an appropriate attitude for the field of secondary mathematics to assume in approaching its post-war problems.

THE FRIDAY NOON LUNCHEON

Due to conditions of the times, the customary Friday evening banquet was not held this year. Instead, a general noon-day luncheon was substi-

tuted. Professor E. R. Breslich, Past President and Honorary Member of the Association, acted as toastmaster and introduced the speaker, Professor Anton J. Carlson, of the University of Chicago, who spoke on the topic. "The Teachers of Science and Mathematics and the Present Crisis."

Professor Carlson presented a very interesting discourse upon the philosophy of education, with especial reference to the contributions which the sciences and mathematics should be making today. He stressed some of the dangers threatened by the accelerated programs now demanded. He offered some very stimulating and thought-provoking criticisms of teachers and common courses of study.

THE SATURDAY MORNING GENERAL SESSION

Dr. Charlotte L. Grant, Arsenal Technical High School, Indianapolis, Indiana, Chairman of the Conservation Committee, brought the history of the Conservation Committee from the time of its inception in 1930 down to the present date. She described the work of the present committee and discussed briefly this year's report which is available in mimeographed form. The report will be published in SCHOOL SCIENCE AND MATHEMATICS.

Professor B. S. Hopkins, of the University of Illinois, spoke on "The Role of the Metallic Elements in Our Present Emergency." He pointed out that the idea of an unlimited supply of the metals was and is false. We have not learned to economize our metallic resources and to use wisely the metals which must be imported. After World War I the United States listed 42 essential items for which we were dependent upon other countries. By 1941 this list had been reduced to 14. Professor Hopkins showed that nothing can be regarded as inexhaustible and that we must learn to conserve.

Several slides were shown which illustrated how the United Nations were fortunate with respect to certain metals and very unfortunate with respect to others.

Professor Hopkins discussed the production of iron, magnesium, aluminum, chromium, manganese, nickel, tin, cadmium, copper, antimony, iridium, tungsten, molybdenum, vanadium and others. He pointed out that gold and silver which are ordinarily considered our rare metals are plentifully abundant and that the need for iron is much more critical than for gold and silver.

Three conclusions were offered: (1) Economy in the use of all metals is necessary. (2) Our natural resources with respect to strategic minerals whose supply is limited should be expanded in time of peace. (3) In case of those minerals of which American resources are not equal to our needs, adequate reserve stocks should be maintained at all times.

R. W. WOLINE

BIOLOGY SECTION

(Joint meeting with the Chicago Biology Round Table)

Presiding: Mr. John C. Mayfield

Mr. John C. Mayfield, Chairman, called the meeting of the Biology Section to order at 3:00 P.M. Friday, November 27, 1942.

The program was designed to carry out the theme of the convention: "Correcting Educational Weakness for Future Strength."

Professor Paul B. Sears of Oberlin College, spoke on the Ecology of Peace. According to Professor Sears peace is a spiritual problem and peace comes only when men deserve it. Ecology is the mutual relationship of living things. The ecology of peace can be attained only when the relationship of the resources to the population is equal to the culture; this he expressed in the formula $R/P=C$. Professor Sears went on to say that aggres-

sor nations maintain a nucleus of warlike culture which expands into armed conflict. This cannot be remedied by money or legislation but must come from realistic culture which combines equilibrium, development, cooperation, and control.

The nominating committee consisting of Miss Lillian Bondurant of Oak Park High School, Chairman; Mr. A. G. Grosche, Waukegan Township High School, and Mr. R. E. Davis, East Aurora High School, gave the following report which was accepted:

Chairman, Cecilia J. Lauby, Thornton Township High School, Harvey, Illinois; Vice-Chairman, A. L. Smith, Central High School, South Bend, Indiana; Secretary, S. Ross Aeby, Oak Park High School, Oak Park, Illinois.

"Strengthening High School Biology" was ably discussed by Miss Helen Trowbridge, President-elect of the National Association of Biology Teachers, Glenbard Township High School, Glen Ellyn, Illinois. Miss Trowbridge believes that a teacher of biology should open the eyes and ears of his students to their surroundings. Understanding should be developed through the knowledge of scientific discovery. She believes the teacher should make science functional, create new ideas, and stimulate initiative. The students should be led to make their lives wholesome, constructive and abundant for all.

Mrs. Francis W. Howes, Flower Technical High School for Girls, Chicago, Illinois, discussed "Making Biology Practical for Girls." Mrs. Howes not only told how biology could be made practical but also gave some splendid examples of the ways in which she put her ideas into practice such as beautifying home windows with a window garden or giving blue tickets to students whose lunch tray displayed a well chosen lunch. According to Mrs. Howes, much biology should be taught in the open air. She also expressed the idea that biology justifies its place in the curriculum only so long as it helps to meet the needs of the students of that period of time in a practical way.

Mr. James O. Clarke, Chief of the Central District, United States Food and Drug Administration, spoke on "Present Day Problems in the Food and Drug Control." Mr. Clarke had much to offer that was immensely interesting and timely. He explained that the history of food and drug legislation went back to the Mosaic law. One interesting point that Mr. Clarke mentioned in reference to our present law is that the law tells the vendor not the consumer what he can do. The federal law is enforced by prosecution, seizure, and injunction. Thousands of different foods and tens of thousands of drug products come under the scope of this law. In order to protect the people from these almost numberless items, the law is couched in general rather than specific terms. Mr. Clarke admonishes teachers of biology to remember that every student is a prospective consumer while some will be prospective producers. Teachers have a great influence over the students who pass through their hands and since this is true they should endeavor to explain the law as a protection to every individual.

CECILIA J. LAUBY, *Secretary*

CHEMISTRY SECTION

Presiding: J. S. Chiddix

Applying New Procedures in the Teaching of Chemistry—Robert L. Ebel

The National Committee on Science Teaching has made the following recommendations: an integrated and continuous science program should be set up for grades 1–12, the science curriculum should be revised to meet

life needs, real life situations should be utilized in science teaching, utilization of suitable material in teaching controversial topics, division of scientific material for problems.

The following procedures in teaching chemistry were suggested: use motivation methods to develop a sense of mastery in the student, use laboratory method of approach and solve problems in consumer chemistry, improve technique in solution of laboratory problems. Solving of laboratory problems should be counted more important than the accumulation of fact.

It was urged that the science program be built around the pupil needs. Practical situations should be utilized. From the interest aroused in the student much scientific knowledge may be taught and the scientific method applied.

The speaker described his experiences in working with a class in beginning chemistry which spent part of their time working in a newly-erected chemical plant near the school. The students gained a keen interest in the project, industrial skills and a foundation in the study of chemistry comparable with that taught in the classroom.

Election of Officers

The nominating committee presented the following names as officers of the chemistry section for the ensuing year: Chairman—Mr. R. W. Woline, Oak Park-River Forest Township High School, Oak Park, Illinois; Vice-Chairman—Mr. John O. Collins, East Technical High School, Cleveland, Ohio; Secretary—Mr. R. W. Moore, High School, Owosso, Michigan. Carried.

Synthetic Rubber—Charles C. Price

A digest of this lecture by Dr. Price will be published later.

An Exchange Teacher—Carrol C. Hall

Mr. Hall related some of the experiences and impressions he gained as an exchange teacher in the Los Angeles City School System teaching in the Hollywood High School during the year 1940–41. The exchange teacher is the King Bee for the first few weeks; then, after that he is just one of the gang—in on the school gossip and asked to participate in all the activities and shoulder the responsibilities of a regular teacher.

Talking shop is one of the grandest things about an exchange. Notes are compared and teaching practices checked. Everyone profits by it. It means real work, harder than staying at home where everything is in place and your routine is well settled. A new slant on the teaching profession is gained. For perhaps the first and only time, a teacher comes to a new job without the pressure of having to make good but rather that it is a limited engagement—an opportunity to learn and observe. The home school can be evaluated in comparison with the new.

An exchange teacher needs a keen sense of humor and the ability to be diplomatic. He is asked many embarrassing questions regarding the two schools.

The exchange provided an opportunity to compare the conservatism of the home school with progressivism of the new. New techniques provide opportunity for every child, they are more democratic, there is more freedom of action and spontaneity among children. The children are weaker in the fundamentals of the three R's and take school tasks less seriously.

Two teacher problems in both fronts stand out: the increasing number of pupil activities with which school time is filled, and the ever-mounting

number of administrative details shoved off on the classroom teacher. The result is harm to the pupil.

The support of the exchange teaching arrangement is a mark of educational growth by the school system that supports it. A real step in the professionalization of teaching at the secondary level.

It is too bad more teachers cannot share in this teaching thrill.

JOHN O. COLLINS, *Secretary*

ELEMENTARY MATHEMATICS SECTION

The Elementary Mathematics Section was attended by about two hundred-fifty teachers of mathematics. They showed a great deal of interest in the program which was put on.

The first part of the program was a demonstration given by the pupils of the Irving Park Elementary School, under the direction of Miss Violet Weisen. She brought to the meeting a group of enthusiastic youngsters who had been well trained in the fundamentals of arithmetic. The audience was delighted at the expert fashion in which these young people were able to handle mentally the fundamentals of arithmetic. This demonstration showed that it is possible to get accurate thinking in the fundamentals if enough energy and effort are put forth.

The second part of the program was a paper written by Dr. Buswell of The University of Chicago. Dr. Buswell had made a very careful study of the mental activities which take place in the study of elementary mathematics. Dr. Buswell's paper pointed out a number of the fundamental skills in arithmetic and show how they may be applied in practical situations. His paper emphasized the psychological approach to this subject. He represents the forward thinkers in the field of arithmetic and his paper will be well worth reading when published in this magazine.

Mr. Turner Chandler, Principal of the Burnside School, next pointed out the strong points found in the Chicago course in arithmetic. Mr. Chandler had made a very thorough study of the fine points found in this course. He pointed out the constructive work and the thoroughness of the committee in dealing with a course of arithmetic from the standpoint of modern education. Mr. Chandler emphasized the fine points in the course of study. He might have picked out some of the fundamental weaknesses but he confined himself to the points which were worth discussion in a constructive way. This is probably the best way to discuss a course of study but at times we have to get at the weak points in order to make for stronger ones.

This first meeting of the Elementary Mathematics Section proved a great success. It is hoped that the teachers of arithmetic in the elementary schools will respond heartily to this organization and develop it into one of the strongest.

The following officers were selected for the coming year:

Chairman—Butler Laughlin, Principal, Harper High School, 6520 S. Wood Street, Chicago, Ill.

Vice-chairman—Sister Sanctaslous, Diocesan Superintendent of the Felician Elementary School, 3800 Peterson Avenue, Chicago, Ill.

Secretary—Violet Weisen, Irving Park School, 3815 N. Kedvale Avenue, Chicago, Ill.

BUTLER LAUGHLIN, *Secretary*

ELEMENTARY SCIENCE SECTION

Presiding: Dr. Paul E. Kambly

The annual meeting of the Elementary Science section was called to order Friday, November 27, 1942 at three o'clock by Dr. Paul E. Kambly,

Chairman. Since the secretary, Miss Illa Podendorf, had accepted a position in Tulsa, Oklahoma, and therefore was unable to attend the convention, Dr. Kambly appointed the Vice Chairman as secretary protem.

Miss Charlotte V. Junge, of the University of Iowa, read a very helpful paper entitled, "Improving Teaching in Primary School by Using the Problem Method." Her detailed account of a unit which she herself had developed with a first year class in the experimental school gave the listeners many suggestions which could be employed in any grade and with any unit.

Very timely was the paper read by Miss Hazel Seguin of State Teachers College, Superior, Wisconsin. Miss Seguin adapted her topic to the present emergency by discussing the question, "Have the Needs of Our Children Changed Since Pearl Harbor?" The paper showed that, while the war situation necessitates emphasis on special problems, children's fundamental needs are the same. Using the framework of the N.E.A. report on social needs, prepared by Dr. W. C. Croxton's committee, Miss Seguin told of the contribution which Elementary Science has already made to child needs and then went on to show how the study of nutrition, salvage campaigns, first aid, etc., can be made to function educationally through the science program.

The following officers were selected for the coming year:

Chairman—Anna E. Burgess, Principal of Miles Standish School, Cleveland, Ohio.

Vice-Chairman—Hazel A. Seguin, Science Supervisor, Superior State Teachers College, Superior, Wisconsin.

Secretary—Clara Steyart, Teacher of Elementary Science, Davenport, Iowa.

ANNA E. BURGESS, *Vice-Chairman and Secretary pro tem*

GENERAL SCIENCE SECTION

Presiding: Mr. H. A. Oetting

The first speaker on the program was Mr. Ira C. Davis, University of Wisconsin. Having been long connected with science teaching and our president in 1938, Mr. Davis is well known to science teachers. A goodly sized group assembled to hear his presentation of "Fundamentals in Science Instruction."

Mr. Erwin Runkwitz, Belleville, Illinois, gave a demonstration of Crowe Electrical Apparatus. This is electrical apparatus for laboratory work or class demonstration. Most of the pieces of apparatus are for the purpose of vividly showing the effects of electromagnetic induction.

The report of the nominating committee was as follows:

For Chairman: Miss Margaret Rio, Oblong Township High School, Oblong, Illinois.

For Vice-Chairman: Mark P. Anderson, Watertown Junior-Senior High School, Watertown, Wisconsin.

For Secretary: Arthur W. Henderson, Community High School, Wood River, Illinois.

The program was closed by an informal discussion of the wide field of "Aeronautics" by E. S. Staples, instructor in the Lewis School of Aeronautics, Lockport, Illinois. It is Mr. Staples' contention that, since the military services are placing increasing stress upon mathematics and physics, these sciences ought to be kept more nearly pure. He ventured the axiom that "aviation is a germ disease; once exposed to aviation, a young person never recovers." Not so many years ago even the technically trained aviation engineer held the following new developments in aeroplanes to be impossible of practical operation: (a) adjustable propellers; (b) sensitive altim-

eters; (c) radial engines of over 800 H.P.; (d) large ships. Relative to the flying wing of the future, it was pointed out that, since the drag increases as the square of the velocity, the thickness of the flying wing would be a drawback. However, since the drag of parts of a plane other than the wing increases as the cube of the velocity, it does here have a distinct advantage.

The section program proved to be quite long but the number of persons remaining for the entire program indicated its worthwhileness and justified the efforts put forth by the speakers.

MARK P. ANDERSON, *Secretary*

GEOGRAPHY AND CONSERVATION SECTION

Presiding: Ruth Weaver Mikesell

A Geography Demonstration Lesson

M. Louis Anderzhon, Oak Park Elementary Schools, and her eighth grade pupils.

The use of maps and globes was the theme of the demonstration lesson. Maps on different projections and globes of several types, also a movable blackboard were on the platform ready for use. The value of the polar projection, and low, middle, and high latitudes were demonstrated. The group demonstrated various methods of calculating distances, and pointed out the importance of distances in the new air routes which have been developed to meet the war needs.

Relative sizes were emphasized by placing a cut-out map of the United States, made to scale, on the land masses of the globe. Places in the news today were located on various maps and globes. The spirit of cooperation within the group was very effective.

Panel discussion:

G. Donald Hudson, *chairman*, Head of Geography-Geology Department of Northwestern University, Evanston, Illinois.

W. J. Hamilton, Superintendent of Schools, Oak Park, Illinois.

Walter Eggert, Professor of Education, DePaul University, Chicago, Illinois.

Miss Monica Kusch, Chicago Heights Schools, Chicago Heights, Ill.

Marion Jordan, Director of Instruction, Cicero, Illinois.

The four topics suggested for discussion:

(1) What types of maps should we present to our students?
(2) What laboratory techniques should be employed in our teaching?
(3) Can geography skills be realized if geography is taught as a fusion subject in the Social Sciences?
(4) What skills does the government expect us to develop in an air-minded age?

Maps are essential, but certain types serve specific purposes, and therefore have limited use. They should be accompanied by other devices. Mercator's projection is very important for navigation. Aerial mosaics are also important. The globe is no more expensive than maps, and much more effective for many purposes. Excellent atlases are being prepared for high school use.

Laboratory type techniques should be employed in high school geography teaching.

As a result of fusion, geography teaching has been spotted in the last twenty years. Social science teachers emphasize social science, and geography teachers emphasize geography.

War, as a motivation device in teaching geography, should be used with discretion. We must train children for everyday citizenship. For this rea-

son, they should learn to know people of other parts of the world—how they live and why.

New Techniques in the Teaching of Conservation

Dr. Charlotte Grant, Arsenal Technical High School, Indianapolis, Indiana.

The techniques discussed are now being used in eight schools in the United States.

A series of pamphlets published by Columbia University are available, and are accompanied by instructions for use.

Interest inventories, outdoor inventories, or travel inventories may be used.

Certain devices, such as trips, help develop desirable attitudes toward community problems such as factories throwing waste into streams, or the preservation of wild life. The use of certain devices before discussion of a problem has proven more effective than following the discussion. Students given pre-study information about an impoverished farm offered half a dozen suggestions as to how this might have been prevented, contrasted with one suggestion where specific information was given following the study.

A visit to the county planning board, hobbies, such as more outdoor activities, photography, a study of such planning as the T.V.A., diaries, scrap books, gardens, a study of climax communities, erosion on the school terrace, insect pests, were some of the numerous devices suggested.

The following officers were elected in the Geography Section:

President: Floy Hurlbut, Ball State Teachers College, Muncie, Indiana.

Vice-President: M. Louis Anderzhon, Oak Park Elementary Schools.

Secretary: Monica Kusch, Public Schools, Chicago Heights, Illinois.

FLOY HURLBUT, *Secretary*

MATHEMATICS SECTION

Presiding: Mr. George Hawkins

Professor W. L. Hart, University of Minnesota, the first speaker, presented an inspiring address: "Short Term and Long Term Effects of War on the Secondary Curriculum in Mathematics." Professor Hart first emphasized that the war-time situation demands that the field of secondary mathematics should arrive at valuable terminal objectives independent of later college contracts, and he mentioned the desirability of a permanent viewpoint of similar nature. He then discussed certain weaknesses which have appeared in the mathematical backgrounds of men in the armed forces. He called attention to respects in which some of this apparent weakness might be considered fictitious, and also considered the implications of admitted weaknesses on our future teaching in the field of mathematics at all levels. He emphasized the present and future necessity for the high schools to recognize the existence of considerable individual differences in mathematical ability and the bearing of related placement measures on the problem of teaching for *mastery*. Also, he pointed out the desirability of *overlearning* in order to create the power to apply mathematics. Then he presented the outlines of immediate measures for the field of mathematics consistent with the preceding viewpoints. In conclusion, he called attention to the necessity for prompt consideration of refreshing new viewpoints as to the content and objectives of secondary mathematics for the post-war period so that this field may be able to assume properly the enlarged responsibilities which will face it then.

The report of the nominating committee comprised of M. D. Oestreicher, Chicago, Illinois; Miss Ann Suter, Indianapolis, Indiana; and C. J. Leon-

ard, Detroit, Michigan, was presented by Mr. Oestreicher, Chairman. The following officers were elected for the following year: Chairman, Franklin Frey, Cass Technical High School, Detroit, Michigan; Vice-Chairman, E. G. Hexter, Township High School, Belleville, Illinois; and Secretary, Miss Mildred Taylor, Fenger High School, Chicago, Illinois.

Mr. Hawkins then presented Dr. H. C. Christofferson, Miami University, Oxford, Ohio, who spoke on "Some Mathematics Problems in Air Navigation." He stated that:

"Secondary Education also had its 'Pearl Harbor' when educational leaders were rudely awakened by the glaring deficiencies which existed in the educational experiences of the youth of America. In spite of the fact that we are living in a world becoming constantly more and more scientific and mathematical in nature, more dominated by machines and techniques which depend upon mathematics and science, more and more dependent upon the kind of thinking that is involved in the learning of mathematics and science, educational leaders were making these subjects more and more elective just because they were difficult and not easily mastered or glamorized.

"In order to fire a gun or fly a plane or plan a campaign, mathematics and science are indispensable terms. It is our function as teachers of mathematics, not to criticize the leadership that has precipitated us into this unfortunate situation, but to plunge in and do our best to remedy matters that are serious. Much of the reason for the elimination of mathematics from the curriculum was the reluctance of teachers of mathematics to face facts, to abandon techniques which have long ceased to serve a useful function, and to make mathematics throb with the life that it naturally has. Every pilot has to know how to use a slide rule for rapid and accurate calculations. He is constantly confronted with proportions to be solved either by slide rule or otherwise. Scale drawings are indispensable to the pilot as the basis for vector diagrams. Formulas, graphs, equations, tables, are the tools with which he deals constantly and inescapably. It is therefore, of paramount importance that young people in our high schools today become thoroughly conversant with the use of these vital instruments of calculation and quantitative thinking. Many new and illustrative types of questions and problems confront the aviator in his work. Even a superficial knowledge of these problems shows the basic mathematics which underlies their mastery. It is the responsibility of the high school teachers to supply training in this basic mathematics upon which the superstructure provided by the Army, Navy, and the Air Corps must be built, as well as the superstructure upon which a post-war civilization must stand."

The third speaker was Mr. Paul Trump, University High School, Madison, Wisconsin, who presented an interesting paper in "Critical Thinking Abilities and Instruction in Mathematics."

The present war emergency magnifies the growing need for training in the skills of mathematics for their immediate tool values. This emphasis must be accompanied by a second emphasis in content and method of presentation to the end that, through the study of mathematics, boys and girls will develop desirable abilities and habits of thinking critically about quantitative data.

Success in developing and applying the skills and methods of mathematics depends on many experiences with meaningful situations. Continuous emphasis on well defined objectives is essential to the development of an understanding of mathematical principles upon which facility and use value must be based. We must use applications as a basis for learning, rather than merely for motivation or as exercises in application.

Pupil experiences with real situations must be such as to suggest a spe-

cific problem to the pupil. The analysis of the problem leads to a discovery of a principle in operation. A relationship is discovered in the analysis of relevant data, and is then expressed mathematically. Full coordination of the situation, involving verbal descriptions, use of the table, the graph and the formula will lead to significant generalization. For most pupils, the techniques of mathematics cannot proceed far beyond such meaningful approaches.

In the teaching of plane geometry we must distinguish clearly between objectives concerned with information and understanding concerning geometric relationships and objectives concerned with abilities to be developed through activities involving proof. If the latter are important and are to be developed, then pupil experience must be geared carefully with that purpose.

E. G. HEXTER, *Secretary*

PHYSICS SECTION

Presiding: Mr. E. O. Bower

The Physics Section of the Central Association of Science and Mathematics Teachers met in Parlor G of the Morrison Hotel, Chicago on Friday, November 27, 1942 at 3:00 P.M.

The Chairman, E. O. Bower, East Technical High School, Cleveland, Ohio, in introducing the speakers related the importance of their papers to the present educational war effort.

G. P. Cahoon, Department of Education, Ohio State University, gave a comprehensive general picture of the teaching of Aeronautics in the secondary schools.

He outlined the reasons for pre-flight training in the high schools. The first reason is a military one requiring a great industrial output second only to steel, and secondly a trained personnel of pilots, mechanics, bombardiers, radio operators and others to man the proposed output of 125,000 planes for 1943. The High School can provide a great deal of fundamental pre-flight training in aeronautics.

The speaker outlined the general features of such a course calling attention to many topics that should be included in pre-flight courses.

Fundamental elementary physics and mathematics, naturally form the skeleton of these pre-flight courses to be adorned with aeronautical terms, and articulated with skills and techniques in model plane building.

A study of the compass and map reading may be included in the course and for stimulation and first hand information the speaker recommended visits to air fields and repair bases, if possible.

The second paper was one dealing with cloud formations in relation to weather presented by Dr. J. G. Albright of Case School of Applied Science, Cleveland, Ohio. Dr. Albright discussed the classes or types of clouds, the names of which are based upon the form and character of the cloud masses. The physical causes of the clouds based upon temperature difference, humidity, pressure variations, and mass movement were briefly discussed. Since the clouds are indications of these physical factors, the clouds can be used for weather predictions. Cloud formations of the proper sequence together with other factors (symptoms) enable one to make remarkabiy accurate predictions of impending weather conditions.

The paper was amply illustrated with beautiful color slides of various cloud formations and interpretations clearly made by Dr. Albright. Thus Weather Bureaus were long antedated by farmers and others whose short range weather forecasts often came true, the information for which the clouds furnished.

The meeting was closed by two brief discussions: one on procedures and

required priorities necessary in the purchase of supplies and apparatus, by Mr. Kincaid of the Central Scientific Company, the other by Mr. Brown of the Welch Manufacturing Company who discussed their new aeronautical charts in relation to pre-flight courses in aeronautics now being offered by many high schools.

The Physics Section elected the following officers for the coming year: Chairman, P. A. Tapley, Physics Department, Von Steuben High School, Chicago, Illinois; Vice-Chairman, C. W. Jarvis, Department of Physics, Ohio Wesleyan University, Delaware, Ohio; Secretary, W. N. Smith, East Technical High School, Cleveland, Ohio.

C. W. JARVIS, *Secretary*

THE ELEMENTARY SCHOOL GROUP

Presiding: Dr. John T. Johnson

The Elementary School Group met in the Roosevelt Room and was called to order by Dr. John T. Johnson, Chicago Teachers' College. There were fifty members and guests present.

Dr. Johnson introduced Mrs. Dorothy V. Phipps, Chicago Teachers' College, who read an interesting paper, "Elementary Science in a Victory Garden." She said that the Elementary Schools play an important part in the war program. We need more foods and these must be grown locally.

Mrs. Phipps told of a garden project that was started and carried out by a fifth grade room in one of the Chicago schools. The work was correlated with other subjects and grew until it became an alive project. The children gained many new experiences and also had actual experiences with farming tools.

The outcomes of the projects were:

(1) Health of the children improved, due to the fact that they were outdoors and in the sun.

(2) Was the beginning of many home gardens.

(3) Children learn the value of foods.

Mrs. Mitchell from the Arnold School, Chicago, told of her actual workings in gardening. She said she had charge of the garden clubs for five years and that the garden club can change the life of a community.

Mrs. Peiper, Bret Harte School, Chicago, related her experiences. She had charge of a victory garden in one of Chicago's congested areas. Results were satisfactory and made the pupils garden and food conscious.

A lively discussion followed these excellent reports. Miss Burgess, Cleveland, Ohio, told of Radio Programs in her city and correlation with science lessons. The entire school system participates in the garden plan. Others who took part in the discussion were Mr. Bibbs, Illinois Institute of Technology, Miss Federico, Dever School, Chicago, Miss Keller, Assistant Superintendent of Schools, Chicago, who gave a very good report of the garden work in her district.

The next part of the program was devoted to Arithmetic. Mr. David S. Cole, Principal of Talcott School, Chicago, read a paper, "Have We Neglected the Teaching of Arithmetic?" In this paper, the writer stressed the need for accuracy in peace time as well as in war. If we have failed in the teaching of arithmetic, we may trace the causes to three sources: (1) Supervisors, (2) curriculum, (3) and the teacher. Our problem now is to improve the arithmetic teaching. The writer went on to quote business houses and their requests for accuracy. The gist of this was that if arithmetic isn't accurate, it simply does not function.

A spirited discussion followed with the following taking part: Miss Federico, Dever School, Chicago; Miss Moore, Gursaulus School, Chicago;

Miss Potter, Supervisor, Racine, Wisconsin; and Mr. Ulrich, Principal, Sherman School, Milwaukee, Wisconsin.

Miss Federico seconded Mr. Cole's discussion on accuracy and Miss Moore also agreed with him but still said that there was a lot of good teaching being done and that teachers didn't have to take a back seat.

Miss Potter electrified the group with her reports. She told of her visits to the factories in Racine and their cries for boys and girls who could change common fractions to decimals accurately.

Mr. Ulrich said that we can help the conditions by helping the teacher and showing her how to do it.

Many teachers in the assembly then took part in the discussion. I am sure that those who attended felt that the meeting was successful and came away feeling that we teachers have an important job to do in this war and that we will do it well.

MISS CATHERINE CULLERTON, *Secretary, pro tem*

JUNIOR COLLEGE SECTION

Presiding: Mr. William W. Gorsline

The Junior College Section met in Parlor G of the Morrison Hotel at 10:00 A.M., Saturday, November 28, 1942.

Mr. M. I. Meyer of Wright Junior College spoke on the "Chemistry of War Gases." He first discussed the toxicity and persistency of the chemical agents and classified the compounds according to their structure and chemical composition, indicating the various groups which account for the toxic and irritating effects. With a series of slides he explained the chemical reactions involved in the preparation of the more important lacrimators, lung injurants, vesicants and sternutators. A brief discussion followed the lecture.

Mr. William W. Gorsline of Wright Junior College spoke on "The Slide Rule and the War." He first called attention to the wide use made of the slide rule as an instrument for calculating quantities such as distance to the horizon and the dip angle required for true altitude of an astronomical body. A large demonstration rule together with a Thatcher Slide Rule was used in the illustration solved before the group. Prorating of quantities of gasoline used in maneuvers by truck, jeep, etc., was done on the Thatcher Slide Rule. Solutions of algebraic equations on the A, Cl and D scales was shown. Quadratic and cubic equations which would have taken hours to work out were solved in a couple of seconds.

Lt. Colonel James W. Moody, Chicago Teachers' Review School, spoke on "Physics and Modern Warfare." He emphasized the value of Physics in the armed forces, both in the Navy and Army, and particularly in the Air Service. He stated that although no formal Physics is required to enter the Air Service, a good knowledge of Physics is essential and in the succeeding training, a thorough grounding in Physics is included in the schedule.

WILLIAM W. GORSLINE, *Chairman*

THE JUNIOR HIGH SCHOOL SECTION

Presiding: Mr. Ira C. Davis

Mr. Ira C. Davis, University of Wisconsin, had assumed the chair in place of the regular chairman who was not in attendance at the convention this year. Mr. Davis first presented himself as stating "The Case for Science." As a second part Mr. Walter W. Hart, Kenilworth, Illinois, presented the "Case for Mathematics." Mr. Leo Herdig, Assistant Superintendent of Schools, Board of Education, Chicago, Illinois disscussed "The Problem of Administering the Program." His discussion was followed by a

lively discussion in which most of the members of the audience participated. The latter discussion included the problems confronted in science and mathematics relative to reading abilities, vocabulary difficulties, grade placement of material, etc.

MARK P. ANDERSON, *Secretary*

SENIOR HIGH SCHOOL MEETING

Presiding: Mr. Nathan A. Neal

The Saturday morning Senior High School meeting met in Parlor F from 10:30 until 12:20.

Mr. A. O. Baker, Supervisor of Science in the Junior and Senior High Schools, Cleveland, Ohio discussed the "Advancing Front in Science Education." Mr. Baker spoke of the new emphasis on science teaching to aid the war effort, and showed moving pictures of science activities related to aeronautics.

Professor Albert Edward Emerson, of the University of Chicago, spoke on "The Evolution of Cooperation." It was pointed out that biological evolution has major social implications, and that biological forces long at work are bringing us closer to a more cooperative and peaceful world order.

Dr. Jerome Sachs was unable to present his paper as announced, due to commitments with the armed services.

NATHAN A. NEAL, *Chairman*

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Missouri

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

1786, 7, 8. *Paul C. Overstreet, Wilmore, Ky.*
1785, 6, 7. *A. J. Zanolar, Collegeville, Ind.*

1781. *Walter R. Warne, Rochester, N. Y.*
1781. *Jane Mooney, Dunder, Mich.*
1784. *Morris J. Chernofsky, Brooklyn, N. Y.*

1738. *Proposed by Nellie E. Walter, Canoga, N. Y.*

If a, b, c are sides of a triangle show that

$$\left(1+\frac{b-c}{a}\right)^a\left(1+\frac{c-a}{b}\right)^b\left(1+\frac{a-b}{c}\right)^c<1.$$

Solution by Howard D. Grossman, New York City

If $0\leqq x<n$,

$$1+\frac{x}{n}\leqq 1+\frac{x}{n}+\frac{x^2}{2n^2}+\cdots\leqq 1+\frac{x}{n}+\frac{x^2}{n^2}+\cdots=\left(1-\frac{x}{n}\right)^{-1},$$

$$1+\frac{x}{n}\leqq e^{x/n}\leqq\left(1-\frac{x}{n}\right)^{-1},$$

$$\left(1+\frac{x}{n}\right)^n\leqq e^x \quad\text{and}\quad e^{-x}\geqq\left(1-\frac{x}{n}\right)^n,$$

$$\text{i.e.}\quad \left(1+\frac{y}{n}\right)^n\leqq y \quad\text{regardless of the sign of } y \text{ as long as } |y|<n.$$

Then

$$\left(1+\frac{b-c}{a}\right)^a\left(1+\frac{c-a}{b}\right)^b\left(1+\frac{a-b}{c}\right)^c\leqq e^{b-c}\cdot e^{c-a}\cdot e^{a-b}=e^0=1,$$

the equality sign holding only when the triangle is equilateral.

1789. *Proposed by Cecil B. Read, Wichita, Kan.*

What restriction is placed upon the triangle ABC, if $\tan A+\tan B+\tan C=\sqrt{3}$.

Solution by Howard D. Grossman, New York City

Let $x=\tan A$, $y=\tan B$, $z=\tan C$, and let A and B be acute. Since $A+B+C=180°$,

$$z=\frac{x+y}{xy-1}\cdot \tag{1}$$

Also since $x+y+z=\sqrt{3}$,

$$x+y+\frac{x+y}{xy-1}=\sqrt{3}. \tag{2}$$

By clearing (2) of fraction, one obtains

$$x+y+\frac{3}{xy}=\sqrt{3}. \tag{3}$$

Hence $x+y<\sqrt{3}$, $xy>1$. Since these are contradictory conditions for real values of x and y, no such triangle exists.

Editor's Note: Malcom Kirk, West Chester, Pa., using the relation, $\tan(A+B)\cdot\tan A\tan B=\sqrt{3}$, analyzes the various possibilities as to size of angles A and B and shows that the given condition is satisfied only when A, B and C are acute. Hugo Brandt, Chicago, shows by calculus that a minimum value of $x+y+z$, is $3\sqrt{3}$, and that $A=B=C=60°$.

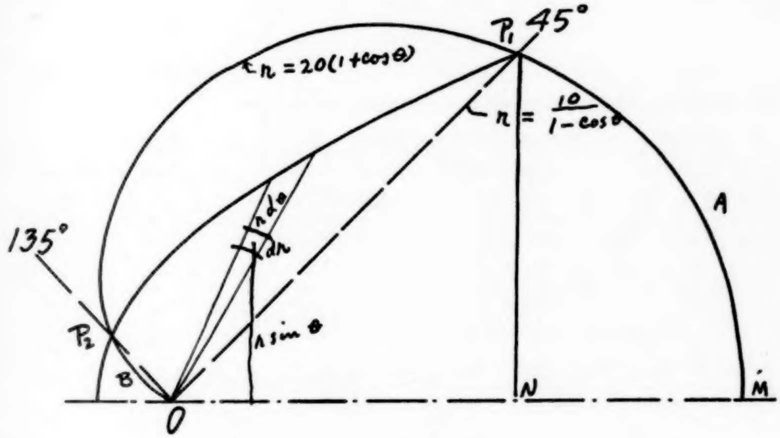
A. Wayne, Flushing, N. Y., also shows the impossibility of the problem.

1790. *Proposed by Helem M. Scott, Baltimore, Md.*

A cardiod $r=20(1+\cos\theta)$ and a parabola

$$r=\frac{10}{1-\cos\theta}$$

having the same origin revolve about the initial line. Find the common volume generated.



Solution by William A. Richards, Berwyn, Ill.

Solving the cardiod and the parabola simultaneously, we find that the two curves meet at P_1 when $\theta=\pi/4$, and at P_2 when $\theta=3\pi/4$.

Let V_1, V_2, and V_3 be the volumes formed by revolving the segments OBP_2, OP_2P_1N, and NP_1AM respectively, about the initial line OX.

Then the volume required is

$$V=V_1+V_2+V_3.$$

Using polar co-ordinates and the double integral, we have:

$$V_1=2\pi\int_{3\pi/4}^{\pi}\int_0^{20(1+\cos\theta)} r^2\sin\theta\,dr\,d\theta=\frac{17000\pi}{3}-4000\pi\sqrt{2};$$

$$V_2=2\pi\int_{\pi/4}^{3\pi/4}\int_0^{10/(1-\cos\theta)} r^2\sin\theta\,dr\,d\theta=\frac{8000\pi\sqrt{2}}{3};$$

and

$$V_3=2\pi\int_0^{\pi/4}\int_0^{20(1+\cos\theta)} r^2\sin\theta\,dr\,d\theta=\frac{47000\pi}{3}-4000\pi\sqrt{2}.$$

$\therefore$ Adding, we have:

$$\text{Required volume}=\frac{16000\pi}{3}(4-\sqrt{2})\text{ cu. units (or approx. 43,326 cu. units)}$$

Solutions were also offered by Hugo Brandt, Chicago, Arthur Danzl, Collegeville, Minn. and Helen M. Scott, Baltimore, Md.

1791. *Proposed by Walter R. Warne, Rochester, N. Y.*

Prove

$$\frac{1-\cos x+\cos y-\cos(x+y)}{1+\cos x-\cos y-\cos(x+y)}=\frac{\tan x/2}{\tan y/2}.$$

First Solution by Aaron Buchman, Buffalo, N. Y.

From a well known trigonometric identity we have

$$\tan x/2=\frac{1-\cos x}{\sin x}=\frac{\sin x}{1+\cos x}$$

$$\tan y/2=\frac{\sin y}{1+\cos y}=\frac{1-\cos y}{\sin y}.$$

Dividing the first continued equation by the second

$$\frac{\tan x/2}{\tan y/2}=\frac{1-\cos x+\cos y-\cos x\cdot\cos y}{\sin x\cdot\sin y}=\frac{\sin x\cdot\sin y}{1+\cos x-\cos y-\cos x\cdot\cos y}$$

$$=\frac{1-\cos x+\cos y-\cos x\cdot\cos y+\sin x\cdot\sin y}{\sin x\cdot\sin y+1+\cos x-\cos y-\cos x\cdot\cos y}$$

$$=\frac{1-\cos x+\cos y-\cos(x+y)}{1+\cos x-\cos y-\cos(x+y)}.$$

Second Solution by M. Freed, Wilmington, Calif.

$$\frac{1-\cos x+\cos y-\cos(x+y)}{1+\cos x-\cos y-\cos(x+y)}=\frac{(\cos y-\cos x)+1-\cos(x+y)}{\cos x-\cos y+1-\cos(x+y)}$$

$$=\frac{2\sin\frac{x+y}{2}\sin\frac{x-y}{2}+2\sin^2\frac{x+y}{2}}{2\sin\frac{x+y}{2}\sin\frac{y-x}{2}+2\sin^2\frac{x+y}{2}}$$

$$=\frac{\sin\frac{x-y}{2}+\sin\frac{x+y}{2}}{\sin\frac{y-x}{2}+\sin\frac{x+y}{2}}. \qquad \left[\text{Dividing by } 2\sin\frac{x+y}{2}\right]$$

$$=\frac{2\sin\frac{x}{2}\cos\frac{y}{2}}{2\sin\frac{y}{2}\cos\frac{x}{2}}$$

$$=\frac{\sin\frac{x}{2}}{\cos\frac{x}{2}}\cdot\frac{\cos\frac{y}{2}}{\sin\frac{y}{2}}$$

$$=\frac{\tan\frac{x}{2}}{\tan\frac{y}{2}}.$$

Solutions were offered also by A. Wayne, Flushing, N. Y.; R. W.

Frankel, Ann Arbor, Mich.; Carl Nyquist, Wilmington, Calif.; Daniel Finkel, Mt. Rainier, Md.; Hugo Brandt, Chicago, Ill.; Jared Newman, Williamsport, Pa.; Arthur Danzyl, Collegeville, Minn.; S. E. Field, Gogebic Junior College, Ironwood, Mich.; M. Kirk, West Chester, Pa.; William A. Richards, Berwyn, Ill.; and Helen M. Scott, Baltimore, Md.

1792. *Proposed by Myrtis Hyatt, Newburg, N. Y.*

If b is a mean proportional between a and c, show that

$$(a+b+c)(a-b+c)=a^2+b^2+c^2.$$

Solution by S. E. Field, Gogebic Junior College, Ironwood, Mich.

$$(a+b+c)(a-b+c)=a^2+c^2+2ac-b^2$$

from which, since $b^2=ac$, we obtain

$$a^2+b^2+c^2.$$

Solutions were offered also by Hugo Brandt, Chicago, Ill.; R. W. Frankel, Ann Arbor, Mich.; A. Wayne, Flushing, N. Y.; George Silcock, Sloatsburg, N. Y.; Aaron Buchman, Buffalo, N. Y.; Ruth Dimmick, Ogden, Utah; Catherine Allen, Winnipeg, Canada; Walter R. Warne, Rochester, N. Y.; William B. Haney, Newark, N. J.; M. Freed, Wilmington, Calif.; Helen M. Scott, Baltimore, Md.; Malcolm Kirk, West Chester, Pa.; William A. Richards, Berwyn, Ill.; Jessie Stewart, Nyack, N. Y.; Elizabeth Raincliffe, West Point, N. Y.; and Morris I. Chernofsky, Brooklyn, N. Y.

1793. *This problem was incorrectly stated.*

1794. *Proposed by Grace Taylor, Bena, Minn.*

If in a triangle $\cos B \cos C=\cos A$, prove that $\cot B \cot C=\frac{1}{2}$.

Since

$$A+B+C=180°$$

$$\cos B \cos C=-\cos (B+C)$$

$$\cos B \cos C=-\cos B \cos C+\sin B \sin C$$

$$2 \cos B \cos C=\sin B \sin C$$

$$\frac{\cos B \cos C}{\sin B \sin C}=\frac{1}{2}=\cot B \cot C.$$

Solutions were also offered by Wm. A. Richards, Berwyn, Ill.; Hugo Brandt, Chicago; R. W. Frankel, Ann Arbor, Mich.; Margaret Joseph, Milwaukee, Wis.; Helen M. Scott, Baltimore, Md., Daniel Finkel, Mt. Rainier, Md.; S. E. Field, Ironwood, Mich.; Aaron Buchman, Buffalo, N. Y.; M. Freed, Wilmington, Calif.; Arthur Danzl, Collegeville, Minn.; M. Kirk, West Chester, Pa.; Chas. W. Hansen, Brown Valley, Minn.; Walter R. Warne, Rochester, N. Y.; and Morris I. Chernofsky, Brooklyn, N. Y.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below:

1791, 2. K. A. G. Miller and D. Pilkington from Upper Canada College, Toronto, Canada.

1794. K. A. G. Miller.

1792. Maxine Simmons, Tulsa, Okla.; Evelyn Burkhart, Sheboygan, Wis.; William Hessler and the following named students from Los Angeles, Calif.: Joy Bupp, George Eckert, Jean Genter, Bill Malseed, Bill Mais, Richard Mayes, Betty Newbrough, Teresa Regan, Ray Shepard, Charles Snyder, Wilbur Thomas, Norman Torgerson, and Doris Wickwar.

1791. Carl Nyquist, Wilmington, Calif.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

PROBLEMS FOR SOLUTION

1807. *Proposed by Cecil B. Read, Wichita, Kan.*

The base of an oblique cone is a circle with center O. The vertex of the cone is P. The line OP makes an angle θ with its projection on the plane of the base. What is the lateral area of the cone?

1808. *Proposed by Marmis Charosh, Brooklyn, N. Y.*

In triangle ABC, attitudes AF, BD, CE meet at H. If $AH=p$, $BH=q$, $CH=r$, prove

$$aqr+brp+cpq=abc.$$

1809. *Proposed by Walter H. Carnahan, Indianapolis, Ind.*

Triangle ABC is scalene with equilateral triangles ABD, ACE and BCF constructed so that they do not overlap.

Show that

1. $AF=BE=CD$
2. AF, BE and CD are concurrent
3. AF, BE and CD form 60 degree angles at point of concurrence.

1810. *Proposed by Aaron Buchman, Buffalo, N. Y.*

If from an outside point P, tangent PT and secants PVW and PXY are drawn to circle O, PVW between PT and PXY, and if $\overset{\frown}{TV}=2a$, $\overset{\frown}{VX}=2b$, $\overset{\frown}{TW}=2c$, $\overset{\frown}{WY}=2d$, prove that

$$\frac{\cot a+\cot b}{\cot c+\cot d}=\frac{\csc^2 a}{\text{scs}^2\, c}.$$

1811. *Proposed by Celia Milleo, Intertaken, N. Y.*

Show that the area of the triangle formed by joining the centers of the escribed circle is $abc/2r$, where a, b, and c are sides of the original triangle and r is radius of inscribed circle.

1812. *Proposed by Helen Morissey, Hartford, Conn.*

If A, B and C are the angles of a triangle prove that $1-8\cos A\cos B\cos C$ is always greater than zero.

The colleges and universities can adjust their entrance requirements so as to serve every qualified student who needs the services of the college to prepare him for war work.

—*John W. Studebaker*

SCIENCE QUESTIONS

February, 1943

Conducted by Franklin T. Jones
10109 Wilbur Avenue, S.E., Cleveland, Ohio

Contributions are desired from teachers, pupils, classes and general readers. Send examination papers from any source whatsoever.

It is natural that questions connected with the War Effort will be especially appreciated.

Questions on any part of the field of science; questions having to do with the pedagogy of science; new applications of old ideas; present variations of perhaps ancient questions; anything that appeals to the reader, or might appeal to other readers—all are wanted.

What interests you, will most likely, interest others also.

We will endeavor to obtain answers to all reasonable questions. It is always valuable to get questions whether we can get the answers or not.

Contributors to SCIENCE QUESTIONS are accepted into the GQRA (Guild of Question Raisers and Answerers).

Classes and teachers are invited to join with others in this cooperative venture in science.

JOIN THE GQRA!

SCIENCE GOES TO WAR IN 1942

You should read the "Summary of this Year's Happenings in Science." It will be found on pages 387–389 and 396–399 in *Science News Letter* for December 19, 1942.

Incidentally, Science is going to stay in war in 1943.

Please send in the things you are doing in 1943 to

KEEP UP WITH SCIENCE AND INDUSTRY.

MATHEMATICS and SCIENCE have come into their own again thanks to the War.

990. What are you going to do to keep them from slipping again when this war is over?

STEEL QUIZ (With Answers)

992. *STEEL QUIZ, No. 56, is taken from STEEL FACTS, October, 1942, published by American Iron and Steel Institute, New York.*

? ? STEEL QUIZ ? ?
No. 56

Seven right out of ten on this quiz is considerably above average. Answers follow.

1. The number of railroad cars needed to haul iron and steel scrap to American steel mills every month is about: (a) *1,500;* (b) *15,000;* (c) *51,000.*

2. Average hourly earnings of steel workers today exceeds the 1929 level by (a) *100 per cent;* (b) *60 per cent;* (c) *35 per cent.*

3. Scrap steel containing chromium can be quickly distinguished from

ordinary steel by: (a) *looking for silvery flecks on the surface;* (b) *holding it against a grinding wheel;* (c) *testing it with a magnet.*

4. Compared with 1918, when one out of every 29 tons of steel produced was alloy steel, in 1942 alloy steels represent one out of every (a) *8 tons;* (b) *16 tons;* (c) *24 tons.*

5. By the end of September 1942, the number of consecutive weeks in which the steel industry had exceeded *by at least 50 per cent* its peak weekly production in World War I was: (a) *64;* (b) *23;* (c) *16.*

6. Steel companies do not regularly purchase either as a raw material or for supplies: (a) *pure platinum;* (b) *pure iron;* (c) *genuine diamonds.*

7. In making some of the new wartime alloy steels, the proportion of nickel needed which can be obtained from the use of nickel-containing scrap is about: (a) *15 per cent;* (b) *55 per cent;* (c) *95 per cent.*

8. Compared with the total of $366,000,000 in taxes paid by steel companies in 1939 and 1940 combined, tax payments of the same companies in the first half of 1942 alone were: (a) *7 per cent higher;* (b) *almost equal;* (c) *only 12 per cent lower.*

9. In the first World War, production of fine electric furnace steels established a new peak up that time of 573,000 tons (1918). This year, production will be: (a) *twice that;* (b) *4 times as great;* (c) *7 times as great.*

10. When tin cans are to be salvaged, they should be kept separate from other kinds of steel scrap because: (a) *both the tin coating and the steel base can be re-used after proper treatment;* (b) *they are too lightweight to mix with heavier scrap;* (c) *they rust faster, and should be remelted more quickly.*

Answers follow. Cover them up. Answer the above and then compare.

ANSWERS TO QUIZ NO. 56

1. (c) Steel plants are now buying over 1,500,000 tons of scrap per month, about 51,000 carloads.

2. (b) Steelworkers today receive an average of $1.04 per hour—60 per cent above the 1929 level.

3. (b) Sparks from a piece of chromium steel held against a grinding wheel come in flower-like bursts. Sparks from ordinary carbon steel go in simple, straight lines.

4. (a) One out of every eight tons of steel produced so far this year is alloy steel.

5. (a) Every week since early July 1941 (64 weeks in a row) steel output has been at least 50 per cent above the 1918 peak.

6. (b) Pure iron.

7. (c) Up to 95 per cent of the nickel requirements of some alloy steels can be obtained from the nickel in selected grades of scrap steel.

8. (a) In the first half of this year, steel companies paid $393,000,000 in taxes, 7 per cent more than total taxes in 1939 and 1940.

9. (c) About 4,000,000 tons of electric furnace steel will be produced in 1942—seven times as much as in 1918.

10. (a) Both the tin and the steel in a tin can are reclaimable.

BAROMETER TO ALTIMETER

991. *Proposed by K. F. Keirstead, M. A., Principal, Saint Andrews Public School, Saint Andrews, New Brunswick, Canada (GQRA No. 270).*

A barometer reads from 400 millibars to 1,013 millibars (360 degrees).

It is desired to convert this instrument into an altimeter by recalibrating to read in feet, by intervals of 5,000 feet.

From the data below draw a graph—

Pressure in millibars	*Altitude in feet*
400	24,370
500	18,520
600	13,740
700	9,700
800	6,200
900	3,112
1,000	348
1,013	Sea Level

Given that the face of the instrument is 4 inches, from the graph obtain the data for the calibration of the dial.*

(In submitting answer please send your drawing, preferably in black ink, so that a cut may be made for publication. On a separate sheet from answer, please. Thanks!)

THE COW AND THE MOON—Still unsettled

952. *From "Brain Teasers" edited by F. Bevington, in the DOUBLE BOND of the Western New York Section of The American Chemical Society.*

Find how much work was done when the cow jumped over the moon. (Her weight in pasture was 900 lb.; but, as she went up, her weight varied inversely as the square of the distance from the center of the earth, and this distance varied from 4,000 miles in the pasture to 240,000 miles at the moon.)

Answer is 1,770 mile-tons.

Solutions

Hollis D. Hatch (GQRA, No. 264), English High School, Boston, Mass. figured that "at a neutral point 216,000 miles from the earth, the cow would be equally attracted by the earth and the moon, and the work to get her there would be 1,760 mile-tons. From there on no work is needed to move her toward the moon; but, if she lands on the moon and jumps off she does 810 mile-tons against the moon's attraction to get back to the neutral point. . . . The total amount of work, i.e. 2,570 mile-tons, is so different from your answer that I prefer mine."

Warren Rufus Smith (GQRA, No. 176), "Sign O' the Sawbuck," Sutton's Bay, Michigan, now rides in and deposes—

"Having ridden in the rodeo in Oregon, I venture to express myself with reference to the cow in No. 952.

"The answers do not apply to the problem as stated. The statement is that the cow jumped *over* the moon, not to it or to it and back. For her to jump over the moon, her course cannot be directly toward the moon, but must take her past the moon at such a distance and such a speed that she will be captured by the moon's attraction and swung around it in orbit in the same way that a comet is supposed sometimes to be captured by the sun. This would be a problem in celestial mechanics for an astronomer, and is entirely beyond me. It would seem to have many possible solutions." W. R. S.

And so the poor cow hangs in space, or is she approaching the earth? What, by the way, might be her impact as she hits the earth on her return trip? What is her speed (or is it velocity)? Will she be in condition to have her beefsteaks

marketed when she is found and possibly re-assembled? How put the brakes on her as she approached the moon so that she might be in some reasonable condition for a round trip return to the earth? Alas, Poor Cow; this surely was not Elsie!!!

Late solutions may or may not be published. ED.

PISCICULTURE

986. *Suggested by recent articles in SCIENCE NEWS LETTER, CLEVELAND PLAIN DEALER, and elsewhere.*

What is the science of pisciculture?

The writers in the above references thought that pisciculture ("fish raising" to you) might find a valuable use in providing cheap and abundant fish for food in a home-made pond down in the little creek behind the barn. It was assumed that carp, quillback, suckers, and others would love to grow, breed and stay in such a quiet place. Such inland waters as Pymatuning Lake, Ohio-Pennsylvania, and many other small bodies of water are already alive and over-crowded with such fish.

Now, the Fish and Game Commissions might willingly offer a gratuitous right to draw the seine in such waters for the sake of getting rid of the pests (some of them planted by past generations of pisciculturists); but the owners of the seines say they are not interested, that they could not pay the expenses of the seining operations and the transport of their equipment from present location and the necessary expense of sorting out the good fish and throwing them back for the amounts they could realize on the sales of the rough fish. Furthermore, who would want to *buy* the fish anyway? If this worthy project of cleaning out rough fish from steams and ponds so as to give good game fish a chance is to be carried out, why not spend some of the tax money that way, and give away the rough fish as a contribution to the war effort? Many a more visonary scheme has already been approved.

RUBBER

978. *Suggested by Articles and News Items here and there.*

Are you following and *trying to understand* the arguments about rubber?

Hit and Miss Synthetic Rubber Facts and Sources.

1. *From Guayule plants*—Intercontinental Rubber Products, Salinas Valley, Cal.

   The plant grows wild in the United States and elsewhere but is cultivated only in Salinas Valley, Cal.

   Rubber is extracted as solid particles and shreds in tissues of the plant. Four year plants may contain up to 18% to 20% of dry weight of plant. Two year plants may contain 9%. (*Science News Letter*, Oct. 10, 1942.)
2. *Soybean Rubber Substitute*—A patented process for obtaining a rubber-like substitute from soybeans (U. S. Patent 2,296,464). (*Science News Letter*, Oct 10, 1942.)
3. *Dandelion Rubber*—National Farm Chemurgic Council (Russia) discovered a rubber-bearing dandelion, known as KOK-SAGYZ, which will produce rubber at approximately one-third less than the present cost of making synthetics. Russia has more than 175,000 acres under cultivation. Rich soil is required. No seed is yet available outside of Russia. (News Item.)

4. *Milkweed Rubber* is a practical possibility. Latex is extracted from certain varieties of milkweed which can be grown in Michigan. Thousands of acres are to be devoted to growing the plants. The chief obstacle is cost. (News Item.)
5. *Perbunan*, "a highly specialized kind of synthetic rubber made of butadiene and acrylonitrile," has high resistance to oil and gasoline, which makes it well adapted for use in self-sealing tanks for fighter planes, linings for filling station hose, gaskets for oil pumps, and any other jobs involving exposure to oil. It is also highly resistant to wear and quite resilient. The cost is high—somewhere between two and three times that of natural rubber. By a year from this fall the total production of butyl rubber will reach an annual rate of 130,000 tons. (*Science News Letter*, Sept. 26, 1942.)
6. *Castor oil, 1 part, to ethyl cellulose, 1 part*, makes a new plastic which can replace rubber in washers, gaskets, gloves, galoshes, etc. where the "bounce" of rubber is not needed. (*Science News Letter*, Sept. 5, 1942, p. 152.)
7. *Rubber Substitutes*
   1. *Butadiene styrene co-polymer type*, commonly known as *Buna-S*, is primarily a tire and tube product.
   2. *Butadiene-acrylonitrile*, commonly known as *Buna-M* is an oil-resistant specialty type rubber.
   3. *Neoprene* is an oil-resistant type rubber made from calcium carbide.
   4. *Butyl rubber*, one of the newer substitutes for rubber, has possibilities for use in tires and tubes. The basic material is iso-butylene.
   5. *Thiokol*, at present a specialty rubber, the base material being ethylene dichloride, has possibilities in tire re-treads. (See the partial answer to 978 in SCHOOL SCIENCE AND MATHEMATICS in the number for October, 1942.)

   Reference on Thiokol—Collier's Weekly for January 2, 1943, pp. 26–28, "Tires from the Test Tube" by J. D. Ratcliff.

SCIENCE AND INDUSTRY

READ the following to keep up in 1943

36. *Everyday experiments with Kitchen Equipment (and a doorbell battery) Life*, November 23, 1942, pages 132–142.
37. "*Science Goes to War in 1942*"—Summary of this Year's Happenings in Science, *Science News Letter*, December 19, 1942, pp. 387–389, and pp. 396–399.
38. "Tires from the Test Tube" (A Reference on Thiokol), *Collier's Weekly*, January 2, 1943.
39. "America's First Crucible Steel"—the twentieth of a series of stories relating chapters in the history of the iron and steel industry in America.

    Copies of previous articles are available. Please send your requests to SCIENCE QUESTIONS DEPARTMENT of SCHOOL SCIENCE AND MATHEMATICS. (They will be forwarded to American Iron and Steel Institute for you.)

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950. *Requests to be put on Mailing Lists of General Motors, and others.*

14. K. F. Keirstead, M.A., Principal, Saint Andrews Public Schools, Saint Andrews, New Brunswick, Canada (GQRA, No. 270).
15. R. M. McDorman, Science Dept., Sudbury Mining and Technical School, Sudbury, Ontario, Canada.

LOOKING AHEAD IN THE ELECTRONIC INDUSTRIES

Remember "electronics"—the bright new word of the future! *Frazier Hunt, CBS.*

The 1917 war was run by telephone; the 1942 war is run by radio.—*E. F. McDonald, Jr., president Zenith Radio Corp.*

Have faith in electronics. It is helping to win the war and it will help to create a better world when peace comes.—*W. R. G. Baker, vice-president, General Electric Co.*

This is a radio war. The troops on the ground, the sailors on the high seas, the pilots in the air, depend on radio for their success and their safety. —*David Sarnoff, president RCA.*

The age of the Americas has come. The world's center of gravity—intellectual, economic and political—has, after 450 years, followed Christopher Columbus across the Atlantic.—*Dr. Nicholas Murray Butler.*

The world of 1940 has already become an antiquity. The scientific developments of the war may have effects on our lives and all civilization more wide-reaching and lasting than any military conquest.—*Dr. M. A. Stine, vice-president du Pont Co.*

Reports from the field indicate how important radio and electronics are to our fighting forces. Radio and electronic equipment are vital—in operation at sea, in protecting the lives of our fighters, and inflicting serious damage on our enemies.—*Commander A. M. Granum, Bureau of Ships, U. S. Navy.*

Propose or Answer Questions.
Either will give you membership in the GQRA.

BOOKS AND PAMPHLETS RECEIVED

Principles of Photographic Reproduction, by Carl W. Miller, Ph.D., *Associate Professor of Physics, Brown University.* Cloth. Pages xiii+353. 15×23.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $4.50.

Atoms, Rocks and Galaxies, by John Stuart Allen, Ph.D., *Assistant Professor of Astronomy and Chairman of Physical Science Survey in Colgate University;* Sidney James French, Ph.D., *Professor of Chemistry in Colgate University;* John Grant Woodruff, Ph.D., *Assistant Professor of Geology in Colgate University;* Clement Long Henshaw, Ph.D., *Assistant Professor of Physics in Colgate University;* and David Woolsey Trainer, Jr., Ph.D., *Assistant Professor of Geology in Colgate University.* Revised Edition. Cloth. Pages x+719. 14×21.5 cm. 1942. Harper and Brothers, 49 East 33rd Street, New York, N. Y. Price $3.75.

Systematics and the Origin of Species, by Ernst Mayr, *The American Museum of Natural History, New York.* Cloth. Pages xiv+334. 15×23 cm. 1942. Columbia University Press, Morningside Heights, New York, N. Y. Price $4.00.

The Oceans, by H. U. Sverdrup, *Professor of Oceanography, University of California, Director Scripps Institution of Oceanography;* Martin W. Johnson, *Assistant Professor of Marine Biology, University of California, Scripps Institution of Oceanography;* and Richard H. Fleming, *Assistant Professor of Oceanography, University of California, Scripps Institution of*

Oceanography. Cloth. Pages x+1087. 15×23 cm. 1942. Price $10.00. Text Edition $8.00.

WAYS OF THE WEATHER, by W. J. Humphreys, Ph.D., Sc.D., *Metero-logical Physicist (Retired Collaborator), United States Weather Bureau.* Cloth. 400 pages. 16.5×25 cm. 1942. The Jaques Cattell Press, Lancaster, Pa. Price $4.00.

THE HIGH SCHOOL SCIENCE LIBRARY FOR 1941–42, by Hanor A. Webb (*Editor of Current Science*), *George Peabody College for Teachers, Nashville, Tennessee.* A Reprint from the Peabody Journal of Education, Volume 20, No. 3, November 1942. 22 pages. 16×24 cm.

TEACHING CRITICAL THINKING IN THE SOCIAL STUDIES, by Howard R. Anderson, *Associate Professor of Education at Cornell University.* Thirteenth yearbook, 1942. Paper. Pages ix+175. 15×23.5 cm. The National Council for the Social Studies, Department of the National Education Association, 1201 Sixteenth Street, N.W., Washington, D. C. Price $2.00 bound in paper; $2.30 bound in cloth.

ECONOMIC PROBLEMS OF THE POST-WAR WORLD, analysis by Alvin H. Hansen, *Lucius N. Littauer Professor of Political Economy, Harvard University and Economic Adviser to the Board of Governors of the Federal Reserve System;* and Laurence E. Leamer, *Instructor in Social Science, University of Chicago.* Paper. 64 pages. 15×23 cm. 1942. National Council for the Social Studies, Department of the National Education Association, 1201 Sixteenth Street, N.W., Washingron, D. C. Price 30 cents.

PAYING FOR THE WAR, A RESOURCE UNIT FOR TEACHERS OF THE SOCIAL STUDIES, by Chester D. Babcock, *West Seattle High School, Seattle, Washington;* Eber Jeffery, *Woodrow Wilson High School, Washington, D. C.* and Archie W. Troelstrup, *Stephens College, Columbia, Missouri.* Paper. 69 pages. 15×23 cm. 1942. The National Council for the Social Studies, Department of the National Education Association, Washington, D. C. Price 30 cents.

SEVENTH ANNUAL REPORT OF HUNTINGTON COLLEGE BOTANICAL GARDEN AND ARBORETUM, by Fred A. Loew, *Director and Head of the Department of Biology of Huntington College, Huntington, Indiana.* Paper. 47 pages. 13.5×21.5 cm. December, 1942.

BOOK REVIEWS

MAN AND THE VERTEBRATES, by Alfred Sherwood Romer, *Professor of Zoology and Curator of Vertebrate Paleontology in the Museum of Comparative Zoology in Harvard University.* Cloth. Pages viii+405. 17×23 cm. 1941. 103 reproduced photographs of museum animal exhibits, dioramas and of wild animals in their habitats. 136 pages showing drawings, tables and diagrams. The University of Chicago Press, Chicago, Ill.

In this work the author attempts to give a brief but fairly comprehensive account of the evolution of the vertebrate through man. This with a minimum of technical detail. The book is designed for college student use in the field of biology. It is comprehensive in scope, giving as it does a connected picture of a continuity of the vertebrate and human evolution as a whole. This is an ideal text on this subject for the student of biology because the

lower vertebrate and human aspects are in one book obviating undue reference reading, releasing the student time for other efforts in the field. Chapter headings: 1—Vertebrate Beginnings—Life In The Water. 2—Modern Fishes. 3—The Conquest of Land—The Amphibians. 4—The Frog. 5—The Origin of Reptiles. 6—Ruling Reptiles. 7—The Origin Of Birds. 8—Varied Reptilian Types. 9—The Origin Of Mammals. 10—Flesh-Eating Mammals. 11—Hoofed Mammals. 12—More Ungulates. 13—A Diversity of Mammals. 14—Primates: Lemurs, Monkeys, Apes, and Man. 15—Human Origins. 16—Human Races. 17—The Human Body: Skin, Nervous System. 18—The Human Body—continued: Internal Organs—Digestive, Respiratory, Excretory, Reproductive, Circulatory, Endocrine. 19—The Human Body—concluded: Flesh and Bone. 20—The Development of the Human Body. Appendix 1—A Synoptic Classification of Vertebrates. 2—Phylogenetic Charts of the Vertebrates.

A. G. Zander

About Ourselves, by James G. Needham, Pages 276+xi. Illustrations by William D. Sargent. The Jaques Cattell Press, Lancaster, Pa. Price $3.00.

This book represents a scholarly presentation of man's place in the living world. It represents a brief philosphical analysis of the development of animal life culminating in man. The author portrays war as a natural result of man's heritage of untamed animal instincts. Government is depicted as a product of the development of cooperative efforts necessitated by the relationships in communal life. The author discusses government and religion as the two great stabilizing agencies in human society.

The organization of the context of the book comprises Part I, Man in His Biological Aspects; and Part II, Society in its Biological Aspects. The material of Part I is devoted to a general summary of the development of animal life as to structure in relation to function. Part II explains in general terms man's sociological and psychological development based on relationships and functions found in lower animal groups. Instinct, folkways, and reason are discussed as components of social behavior in man.

The book offers a stimulating and thought-provoking analysis of a subject which is of especial interest in these times.

Jerome Isenbarger

Mathematics for Electricians and Radiomen, by Nelson M. Cooke, *Chief Radio Electrician, United States Navy; Member Institute of Radio Engineers.* Pages viii+604. 15×23.5 cm. 1942. McGraw-Hill Book Company, Inc. New York, N. Y.

This book, as the title indicates, is a textbook on elementary mathematics written especially for electricians and radiomen. No mathematical knowledge is assumed, but a good background and acquaintance with electricity are necessary.

After each mathematical topic is discussed, applications to radio and electrical circuits are given. Starting with literal numbers, addition and subtraction, the author gives a fairly complete discussion of high school algebra, exponents and radicals, logarithms, trigonometry through the solution of right triangles, and finishes with a thorough discussion of complex numbers and their applications to alternating current theory.

The text is very clearly written. All mathematical terms used are carefully defined and explained. Each topic is illustrated by instructive problems. There are many useful and interesting exercises—mostly based on electrical and radio topics.

The book is obviously the result of long thought and careful planning. But, to mathematicians, there is a common flaw in all such books written

for technical purposes. They give many results and formulas but do not give the overall general ideas applicable to all cases. For example, the student is told that $x=-b/2a$ will make $y=ax^2bx+c$ a maximum or a minimum but no reason is given even though a simple proof by completing the square is available.

The idea of function is not introduced. Because of that the author has to make some tricky explanations in order to go from the solution of the quadratic equation to the graphing of the quadratic function.

All in all, however, this book is an excellent one in its class. It should also prove useful for instructors who are looking for problem material with practical applications.

BERNARD FRIEDMAN
Wilson City College
Chicago, Illinois

FIRST YEAR ALGEBRA, ELEMENTARY COURSE, by Herbert E. Hawkes, Ph.D., *Professor of Mathematics in Columbia University*, William A. Luby, *Professor of Mathematics and Chairman of the Department in the University of Kansas City*, and Frank C. Touton, Ph.D., *former Professor of Education in the University of Southern California*. New Edition. Cloth. Pages viii+495. 12×18.5 cm. 1942. Ginn & Company, Boston, Mass. Price $1.40.

Chapter I of this New Edition of the authors' First Year Algebra has been rewritten with the purpose of presenting algebraic symbols and the simpler types of equations more effectively. There is an abundance of exercises involving translation from verbal statements into algebraic symbols. Such exercises tend to develop the ability of the student toanalyze and to set up equations for the verbal problems which are introduced as early as page 16 and which receive a great deal of emphasis throughout the text. In the words of the authors: "The use of algebraic symbols and methods in the solution of verbal problems is the best evidence of real progress in algebra. Teachers today realize more than ever before the possibility of improving the students' ability in comprehension and reading through proper instruction in the solution of verbal problems."

The work on formulas has been extended in scope so as to include many interesting applications to geometry and science. In addition to varied practice in evaluating formulas a limited number of exercises in the derivation of formulas is offered for the more able student.

Graphs are introduced early in the text and are made on integral part of the course. Since many types of graphs involve the idea of proportionality, the authors have deemed it desirable to present the main work in graphs just after the work in ratio and proportion.

Enrichment is attained by the inclusion throughout the text of some nineteen or twenty interesting historical notes which are placed adjacent to related material.

In the chapter on exponents work is offered to give the students experience with numbers written in the form 2.27×10^{12} or in the form 3.45×10^{-8} which are often encountered in chemistry and physics.

Each chapter is concluded with a summary and a list of review questions. Supplementary lists on each chapter are also provided at the end of the book.

The text is finally concluded with a sample objective test "in order that the student may familiarize himself with the type of questions used in this increasingly widespread type of examination."

JAMES B. MAUS
Lyons Township High School

ELEMENTS OF SPHERICAL TRIGONOMETRY, by James E. Thompson, *Department of Mathematics, School of Science and Technology, Pratt Institute.* Cloth. Pages xi+144. D. Van Nostrand Co. New York, Price $1.62.

To evaluate this text we need to consider the purpose of a course in spherical trigonometry. If the purpose of such a course is to present the various formulas and theory relating to triangles on a sphere, this text is highly satisfactory. An excellent review of spherical geometry and plane trigonometry is provided. The fundamental formulas are developed for the general triangle, and the right angle formulas are deduced from these general formulas. The methods of solution of triangles are carefully explained and well demonstrated. Many drill problems are provided. A large number of applications to geometry and to the terrestrial and celestial spheres are given.

If the purpose of a course in spherical trigonometry is to prepare students for marine or air navigation, the theory could be shortened and more practical applications given. The author's discussions of track and of great circle sailing give little idea of the problems encountered in laying out a sailing course. Parallel sailing, mid latitude sailing, and Mercator sailing add to an understanding of the terrestrial sphere, and are valuable for many students at the present time. Some consideration of the modern methods of solving the celestrial triangle should also be given.

Apart from the exceptions noted above this is an excellent text. Terms are well defined. The theory is extensive and well developed. A good selection of problems is given. Instructors giving a course in spherical trigonometry should examine this text.

HILL WARREN
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ASTRONOMY, MAPS, AND WEATHER, by C. C. Wylie, *Professor of Astronomy, State University of Iowa.* Cloth. Pages x+443. 15×23 cm. 1942. Harper and Brothers Publishers, New York, N. Y. Price $3.00.

This book leaves the reviewer with somewhat mixed emotions. The preparation is fundamentally different. The title, however, is misleading. There are 440 pages of text, but only one chapter (19 pages) is devoted to maps and only three chapters (62 pages) to weather.

The author is an astronomer, which probably explains the emphasis upon that portion of the material covered. This section is accurate, well written, and adequately illustrated, particularly the chapters covering constellations and telescopes. It is questionable, however, if 163 pages should be devoted to the moon, eclipses, planets, meteors and the sun, since the book was written "at the request of the Air Corps Flying Training Command" for the use of men in the Army Air Corps Enlisted Reserve.

The material in the chapters on seasons and weather is, in many cases, obsolete. For example: A diagram of climatic zones uses parallels as boundaries and labels the zones torrid, temperate, and frigid—a procedure recognized as inaccurate and undesirable many years ago; a diagram of wind and pressure distribution on the earth shows the prevailing westerlies extending to the poles, hence there is no mention of a polar high, sub-polar low or polar easterlies; a nimbus cloud is described, but this type of cloud is no longer recognized by the United States Weather Bureau; finally, several weather maps are reproduced but they are a type of map no longer in use, i.e., no fronts are indicated and the isobars are given in inches rather than millebars. These mistakes should not appear in a 1942 textbook.

The single chapter dealing with maps has a good general discussion, but

map projections are inadequately treated. Four of the principal projections are mentioned and described briefly, but illustrations are lacking. The average student has difficulty in comprehending this subject even when his text is profusely illustrated, hence it is doubtful if he will obtain an appreciation of maps if his information is entirely descriptive.

It is probable that this text was prepared under pressure in order that it might be available for fall classes. If so, that is unfortunate, for, despite the desirable features, the use of any book as a text is limited if it is characterized by obsolete material or inadequate treatment of any subject included within its cover.

ALDEN CUTSHALL
University of Illinois

MILITARY AND NAVAL MAPS AND GRIDS, by William W. Flexner, *Department of Mathematics, Cornell University*, and Gordon L. Walker, *Department of Mathematics, University of Delaware*. Paper. Pages 95. 14×20 cm. 1942. The Dryden Press, Inc., 103 Park Avenue, New York, N. Y. Price $1.00.

The authors have confined this small manual to five of the principal map projections. Their choice should be quite satisfactory to geographers, cartographers and navigators alike. They have used the Gnomonic, the Mercator, the Lambert Conformal Conic with Two Standard Parallels, the Stereographic, and the Polyconic. The properties of these maps are discussed but the emphasis is placed upon their use in the solution of military and naval problems. There has been no attempt to treat map symbols of their uses. Presumably information of this nature will be obtained from supplementary and more general sources.

Maps are required in many of the exercises, though no maps have been included. Instead, the authors list a few desirable ones that can be obtained at small cost from the Coast and Geodetic Survey and the Hydrographic Office. This is both an advantage and a handicap. It is true that any maps reproduced probably would have only limited value. However, a few small scale illustrations would serve to simplify the discussion of the projections used.

The manual serves the purpose for which it is intended; i.e., "to introduce to students without extensive mathematical background the general principles of map construction and use of maps." It probably includes more mathematics than most introductory books on the subject, but students with a knowledge of plane trigonometry should experience no unusual difficulty. It is suitable for a study of map projections, but will be of little value in a course which is primarily map interpretation or map appreciation.

A probable criticism of merit is the price. It seems that a paper bound pamphlet having less than 100 pages of ordinary quality and containing no expensive illustrations could be printed more cheaply.

ALDEN CUTSHALL
University of Illinois

COMPARATIVE VERTEBRATE ANATOMY, by Libbie H. Hyman, *American Museum of Natural History*. Cloth. Pages xx+544. 18×25.5 cm. 1942. The University of Chicago Press, Chicago, Illinois. Price $3.50.

It is the opinion of those who have used Hyman's new edition of Comparative Vertebrate Anatomy that it is still the best text available for this course of study. However the greatly increased size of the new edition, although it contains much important material, makes it more adaptable for a course covering two semesters of work.

The organization of the new edition is the same as that of the old one with certain exceptions. The chapter on General Study of Typical Chordates in the older edition has been divided into two chapters, namely Essential Features of Lower Types and External Anatomy and Adaptive Radiation in Gnathostomes. The textual material of these latter chapters together with the remaining chapters of that text has been thoroughly revised and considerably expanded with the intention of producing a book which would serve as a textbook as well as a laboratory manual.

In this revision the laboratory directions have been left practically unchanged. Some changes have been made in terminology, errors in the older text have been corrected and some new material has been introduced, especially in the skeletal and muscular systems. Many new figures have been added and some old ones, deemed erroneous, have been dropped out.

In the opinion of the reviewer this text should serve as a valuable reference book as well as a useful text for students of comparative vertebrate anatomy.

Hilmer C. Nelson
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Modern Medicine, by Netta W. Wilson, *Minnesota State Department of Health*, and S. A. Weisman, M.D., *Assistant Professor of Medicine, University of Minnesota, Minneapolis, Minn.* Cloth. Pages vi+218. 14×20.5 cm. 1942. George W. Stewart, Inc., 67 West 44th Street, New York, N. Y. Price $2.00.

This book is not a history of medicine, but a review of the main ideas, discoveries and cures that have advanced the practice of medicine from its crude state in the days of human savagery to its present high degree of development. It is written in such an interesting narrative style that the reader's attention is held from cover to cover. The discussion of unsolved problems and the opportunities for careers will especially interest young men and women who wish to serve their fellow men. The book is written n nontechnical language primarily for the layman and should be the valued possession of every family.

A list of the chapter headings gives an idea of the content of the book. 1. Modern Medicine Looks Backward. 2. Microbe Murderers, The Story of Bacteria. 3. The Invisible World, The Story of Virus Diseases. 4. "Great Fleas Have Little Fleas." 5. Protection in a Nutshell, The Story of Vaccines and Serums. 6. Guinea-Pig Heroes, The Story of Animal Experimentation. 7. Valentines, Valves and Ventricles. 8. The Story of Blood and Some of its Diseases. 9. The Slayer of Youth, The Story of Tuberculosis. 10. Gangster Disease, The Story of Cancer. 11. Life-Saving Knives and Needles. 12. The Gift of Sleep. 13. Circus Freaks and Ordinary People. 14. Eat, Drink and Be Merry. 15. Modern Medicine Looks Forward.

The reviewer recommends this book to every intelligent adult who wishes to know something about human physiology and the whys and wherefors of modern medical practice. The volume while admirable in other respects does not give sufficient emphasis to the increasingly recognized importance of heredity in modern medical practice.

Hilmer C. Nelson

Radio Programs Intended for Classroom Use, by Carroll Atkinson, Ph.D., *Peabody*. Cloth. Pages 128. 13.5×15 cm. 1942. Meador Publishing Co., Boston, Massachusetts. Price $1.50.

This is a very instructive and illuminating little volume on the possibili-

ties of radio as a tool in the educational process. The author discusses the history of the development of educational programs by the large broadcasting chains and the various state colleges and universities as well as public school systems, and evaluates the educational programs developed by these agencies. The author advocates the closer integration of radio programs designed for classroom instruction with regular school work and holds that learning can be just as effective through audio as through visual perception.

The author believes that a plan whereby radio programs and other audio media could be substituted for book reading is worthy of trial not only as a means of training of audio-learning ability in the acquisition of facts to be used in developing thinking habits, but also as a means of avoiding eye strain.

HILMER C. NELSON

BROADCASTING TO THE CLASSROOM BY UNIVERSITIES AND COLLEGES, by Carroll Atkinson, Ph.D. Cloth. Pages 128. 13.5×15 cm. 1942. Meador Publishing Co., Boston, Massachusetts. Price $1.50.

In this volume the author has recorded the history and development to present day of the broadcasting of radio programs directed specifically to students in the classroom by thirty-eight American universities and colleges that have made the attempt, more or less successfully, to conduct instruction in specified subjects over the air.

The programs range from the extensive state-wide, well-organized plan of the University of Wisconsin in successful operation since 1931 to the three monthly transcribed programs offered in the spring of 1941 by South Dakota State School of Mines. While some of the "classroom" broadcasting has been well organized and motivated primarily by a genuine spirit of service, much of it has been directed, according to the author, to high school students undoubtedly for the purpose of encouraging future attendance on the broadcasting institution's campus.

A few of the important elements presented are (1) the story of the first broadcast by any educational group to a classroom; (2) early attempts to provide radio service for rural schools in Kansas and Nebraska; (3) major network broadcasting of classroom programs by three state universities; (4) band instrument instruction via radio; and (5) experimental broadcasting to a hill-billy county in Kentucky.

According to the author the volume was written not only to give educators the opportunity to judge for themselves what has been practical and impractical in this specialized type of broadcasting but also, for textbook writers, to furnish a source of information concerning radio's role in modern education.

HILMER C. NELSON

UNSCREWABLE CROWN BOTTLE CAP

In these days when bottle caps are being carefully salvaged, there should be a ready welcome for a re-usable crown bottle cap invented by Clarence S. Jackson of Brooklyn and protected by patent 2,304,826. The cap is pressed over the beaded neck of the bottle in more or less conventional fashion. However, the neck bead is cast in the form of a screw thread instead of the customary continuous ring, so that the cap can be unscrewed instead of having to be pried off. It is therefore good for repeated use.

ARMY AIR FORCES OFFER NEW METEOROLOGICAL TRAINING

Mastery of the Science of Meteorology requires proficiency in and thorough knowledge of higher mathematics and physics. To train Weather Officers in these and in other related subjects, a threefold educational program has been devised, open to young men of America, possessing good health and scientific aptitudes. The length of the course of studies will vary according to the academic background of the individual.

Under plan "A," or Advanced Meteorology, open to men of 18 to 30 years inclusive, a student who has completed two years of college, with higher mathematics through differential and integral calculus and one full year of college physics, will receive a further eight months' training in topics dealing with weather and with weather forecasting.

Under plan "B," or Premeteorology, open to men of 18 to 30 years inclusive, and of six months' duration, is available to students having completed one year of college with mathematics through college algebra, trigonometry, and analytic geometry.

Plan "C," or Basic Premeteorology, twelve months in length, is designed for the high school graduate, 18 to 21 years inclusive who has mastered algebra and plane geometry, and has completed one year of high school science.

Both "B" and "C" programs prepare students for entry into the "A" course.

In each of the three meteorology courses, accepted applicants are enlisted in the Army Air Forces, receive Army pay, uniforms and living allowances. Upon successful completion of the Advanced course, students are eligible for commissions as Second Lieutenants in the Air Corps and will be placed in the field to operate weather stations at our many air bases.

It is the opinion of many educators that this is the most unusual educational opportunity ever offered to American Youth. All subjects in the three programs are given at the college level and credit toward an academic degree will be granted at all of the participating twenty-nine geographically distributed colleges and universities. Even more noteworthy is the vital character of the work to be performed at the conclusion of the training. Most, if not all, of the graduated weather officers will be moved to combat zones, to serve as central cogs in our war machine.

Both civilians and enlisted men may apply if qualified. The full particulars concerning the Meteorology training may be had by writing to:

"Weather"
Chicago, Illinois

The scientific emphasis of the program has contributed materially to the existing demand for capable instructors of mathematics and physics. Men with teaching experience in these subjects are requested to communicate with Dr. Carl G. Rossby, Head of the Meteorological Institute of the University of Chicago to obtain full information on teaching openings.

The facilities in our trade and vocational schools, and in our more general high schools must be used to whatever extent is practicable in the preliminary preparation of auto-mechanics, radio operators and repairmen, machinists, typists, cooks, and a host of other specialists.

—*John W. Studebaker.*